
D. Ralph Millard Jr.

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CLEFT CRAFT
THE EVOLUTION OF ITS SURGERY
III. ALVEOLAR AND PALATAL DEFORMITIES

D. RALPH MILLARD, JR., M.D., F.A.C.S.
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OF ITS SURGERY

III
ALVEOLAR AND PALATAL
DEFORMITIES

D. RALPH MILLARD, JR.
M.D., F.A.C.S.

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CLEFT CRAFT I, II and III, with the aid of the world literature and my personal experience, have attempted to chart the progress, create logical order, highlight the soundest principles and most effective modifications while condemning dangerous, obsolete and inadequate approaches in the evolution of the surgery of clefts of the lip, palate and face, from the first known Chinese work of A.D. 390 through part of A.D. 1980.

Webster described evolution as a process of continuous change from a lower, simpler or worse state to a higher, more complex or better state. In Roget's Thesaurus, synonyms for evolution include: development, unfolding, growth, rise, maturation; entelechy, phylogeny, ontogeny, physiogeny, mitosis, vacuolation, evolutionism, Darwinism. Darwin believed in natural selection and survival of the fittest. So, too, the evolution of surgery of clefts has progressed by trial and error, results and evaluations, toward selection of surgical methods and survival of the best of these through 1,590 years.

In recording this surgical evolution, I have endeavored to follow two basic principles taught me by my father, an attorney and true southern gentleman. Abstracted they are: the importance of integrity and the necessity of persistence.

D. R. Millard
I. Basics
1. Pertinent Embryology

There are many missing links, and much is still unknown about the embryology of the human face and head. This deficiency is not surprising with so much happening in such a short period of time. Anatomist Robert Bean calculated:

If the rate of growth of the first month of embryonic life were to be maintained until adulthood, the resultant individual would be $128,350$ to the $1,100$ power light years in length.

The Dicksons clarified the perspective of this figure when they determined that such a rate of growth, if continued, would produce a person who at 4 years would span the galaxy, by 6 years would span the universe and as an adult could hold the universe in his hand like a grain of sand.

Veau

In 1938 Veau proposed—and he was seconded by Streeter in 1951—that masses of mesoderm migrate between two continuous sheets of ectoderm covering the face and roof of the primitive oral cavity. Stark added in 1954 that unless this ectoderm is supported by an intervening layer of mesoderm it will eventually break down and give rise to various degrees of clefting.

The secondary palate posterior to the incisive foramen is formed by fusion of the two palatal processes which are vertical outgrowths of the maxillae. Lying at first vertically at each side of the tongue, these palatal folds ascend as the neck extends and the tongue descends. Then, between seven and eight weeks, if all goes well they fuse with each other and with the inferior border
of the septum from before backwards, to form most of the hard and all of the soft palate. Failure of fusion, of course, produces various clefts of the secondary palate.

STARK

In 1971 at the Melbourne Congress Richard Stark reviewed the embryological development of the face, including the palate. He noted:

The secondary palate develops as the result of the positional change of palatal processes or shelves, then by their growth and adherence and finally merging of their mesoderm.

At the seventh week the head is acutely flexed and turned to the right. The tongue is thus pushed cephalad between the palatal shelves, which hang downward on either side of the tongue like the ears of a hound dog. Slowly, as the head begins to extend the tongue begins to drop, starting first at the base of the tongue posteriorly. The palatal shelves seize this opportunity to overcome the tongue resistance and start to rise, first posteriorly, then forward as a wave until the anterior portion completes the positioning of shelves above the tongue.

Now the shelves grow, meet and, if they are sufficiently adhesive, fuse, first at the anterior one-third of the hard palate, then forward to the incisive foramen and lastly backward to the uvula.

In the Transactions of the Fifth International Congress of Plastic and Reconstructive Surgery Stark postulated:

A number of things can occur which can cause this series of events not to take place, with a resultant cleft palate. (1) Increasing upward resistance of
the tongue, such as in Pierre Robin syndrome where the jaw is small and the
tongue is pushed upward between the palatal shelves. There is no opportu-
nity then for the shelves to rise over the tongue to meet and fuse. (2) The
shelves themselves may be so deficient of mesoderm that they cannot grow
and meet each other. (3) The force to lift the shelves up may not be present,
as is true in animals treated by excessive doses of cortisone, vitamin A, or
X-ray. (4) A broad head as in oxycephaly may prove too wide for normal
shelves to meet. (5) There may be postfusion rupture, as suggested by the
presence of epithelial pearls found along the cleft margin by Kraus. (6) The
head may not extend or stay flexed, in which case the tongue is pushed
upward and the palatal shelves are unable to get into proper position for
fusion. This would be true in Klippel-Feil syndrome. (7) An encephalocele
may hang between the shelves, proving an insurmountable obstacle.

PATTEN

Bradley M. Patten of the University of Michigan noted in Cleft
Lip and Palate (edited by Grabb, Rosenstein and Bzoch in 1971):

The palate is contributed to by the nasomedial processes. From their deeper
portions, the small, triangular, median part of the palate is formed. It is to
this portion of the palate that I would restrict the use of the term *primary
palate*. The main part of the palate is derived from that portion of the upper
jaw which arises from the maxillary processes. Shelflike outgrowths of these
processes arise on either side during the seventh week, and grow toward the
midline. These *palatal shelves* form the *secondary palate*. When the palatal
shelves first start to develop, the tongue lies between them, and they are
directed downward so that their margins lie along the floor of the mouth on
either side of the root of the tongue. As development progresses, the
position of the tongue is shifted downward and the margins of the palatal
shelves are free to swing upward and toward the midline. . . . Much more
information is needed concerning this process. . . . On the basis of the best
available age-length data, this places the withdrawal of the tongue from
between the palatal shelves as occurring toward the end of the eighth week,
presumptive fertilization age. . . .

When they first move up, the shelves are not sufficiently developed to
meet each other. Their growth is vigorous, however, and by the eighth
week, they have made contact. Thereafter fusion progresses from the rostral
part toward the uvula. Burdi is convinced that the typical fusion of the
palatal shelves with the characteristic incarnation of epithelial remnants does
not extend to the uvula end of the soft palate. He regards the absence of
epithelial remnants in this territory as indicating that the lengthening of the
soft palate and the formation of the uvula is brought about by merging rather than fusion. . . . At the same time that the palate is thus being formed, the nasal septum grows downward toward it and soon becomes fused to its upper face.

Patten championed the theory that growth of mesenchymal masses beneath the surface brings originally separate structures together in the lip by pushing the epithelium out from between the elevations in the process of *merging*. Yet in the palate he accepted the *fusion* theory, except in the uvula.

One of these is familiar in the formation of the palate. For this process the usual term *fusion* is entirely appropriate. As the two processes come together, the covering epithelial layers are brought into contact. Shortly thereafter, the epithelium that no longer has an external exposure begins to regress. . . . The epithelial changes in this process have been well described by Barry.

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**POSWILLO**

David E. Poswillo has long been interested in the pathogenesis of cleft lip and palate. Upon completion of his oral surgery training in England, he returned to New Zealand in 1953 as senior oral surgeon at the Plastic Surgical Unit, Christchurch, and co-director of the cleft palate clinic. He explained how he got started:

I got into palatal study in New Zealand because I was attempting to find an animal model in which I could do control experiments on the surgical repair of the palate. Ironically, some years after I had been struggling to find a reasonable model of cleft lip and/or palate, my work became well known. As
a result of a newspaper article, a lady who lived only a few hundred yards from my hospital rang me up. All the time I had been working to produce an animal model of cleft lip and palate, she had been trying to breed the same malformation out of her pedigree colony of dachshund dogs. Luckily she had not succeeded and then for a year or two my plastic surgical colleague, John Roy, and I carried out further experiments on the dog model at home at our expense.

Poswillo’s work was recognized by Sir Harold Himsworth, Secretary of the Medical Research Council of Great Britain, during a search visit to New Zealand. His report to the British government stated that the most exciting research he had seen on his one-month visit was being carried out at the bottom of a garden in Christchurch by a young man called David Poswillo. In 1968 Poswillo devoted his first Hunterian Lecture to the isolated cleft palate and particularly the form that is associated with postural molding, entitling the lecture “The Aetiology and Surgery of Cleft Palate with Micrognathia.” Poswillo eventually became professor of teratology in the Royal College of Surgeons of England and consultant oral surgeon at Queen Victoria Hospital, East Grinstead.

In the May 1974 *Proceedings of the Royal Society of Medicine* he wrote:

For thousands of years mankind has been intrigued by disturbances in the physical development of the human body. Even before descriptions of such deformities were recorded on the clay tablets of Babylon, in 3000 B.C., they were illustrated in the rock drawings of primitive cave dwellers. But it was not until the time of Harvey, in the seventeenth century, that the scientific study of malformation began. After the development of the cell theory the significance of the foldings and invaginations of the three germ layers came to be understood, and it was possible to comprehend many anomalies of development in terms of mechanical difficulties. For example, cleft lip and palate became recognized as a failure of fusion of the maxillary processes.

Clefts of the posterior palate may be classified into two principal groups. In one there are those clefts, both unilateral and bilateral, which accompany cleft lip. In the other are the solitary clefts of the secondary palate. Clinically these two groups may easily be distinguished. Most authors agree that these two groups are distinct entities. The difference in incidence, sex predisposi-
tion and prevalence of associated anomalies all support this division into cleft lip and isolated cleft palate.

The frequent association of cleft palate with the cleft lip anomaly has been investigated by many workers. As has already been described, animal embryos susceptible to cleft lip have a large median nasal process. Trasler & Fraser (1963) have shown that in such circumstances, at the commencement of palatal shelf closure, the tongue does not move forward between the lips as is usually the case. Instead the tip of the tongue remains pressed against the median process and arches up into the nasal cavity between the palatal shelves. Thus movement of the shelf or shelves towards the midline is impeded. Therefore in an embryo with cleft lip it is likely that cleft palate results because movement of the shelves from vertical to horizontal is delayed by the intervening tongue. If eventually the shelves do become horizontal it is unlikely that they will meet each other or the nasal septum; thus fusion fails to take place.

The prevalence figures for isolated cleft palate are lower than those for cleft lip and palate, but the ratio of racial incidence is much the same. In Caucasians it occurs once in 3000 live births. An excess of females over males in the ratio of 60:40 exists in isolated cleft palate. Associated congenital anomalies occur twice as often with isolated cleft palate as with combined lip and palate clefts. Micrognathia has a very high association with isolated cleft palate due in part to the simultaneous occurrence of the two anomalies in the Pierre Robin syndrome.

Normal palate fusion involves synchronized interaction between growth and convergence of the palatal processes, tongue withdrawal and muscular activity, mandibular growth, changes in cranial base and cranial flexure, and steady increases in the width of the developing head. It can be postulated that any significant interference with these time-specific interactions could lead to incomplete fusion of the palatal shelves, both with each other and with the nasal septum. In addition, changes affecting the fusion and subsequent breakdown of the epithelial seam could induce malformation. Shelves which merge and fuse could be later disrupted, either by abnormal mechanical pressures or by growth traction if mesodermal bridging is incomplete. Such phenomena could lead to palatal fistula, submucous clefts or even complete rupture of the palate. One can hypothesize, therefore, that cleft palate may arise from one or more of the following causes: interference with the intrinsic shelf force; excessive head width, or diminutive palatal shelves; excessive resistance from the tongue; non-fusion of the palatal shelves; and fusion of the palate with subsequent breakdown.

Walker and Fraser (1956) were the first to propose the existence of an intrinsic shelf force which they ascribed to the presence of elastic fibres
within the shelf mesoderm. Poswillo and Roy (1965) believed that the intrinsic shelf force arose from a combination of the expanding fibrillar mesoderm and increased mitotic activity along the lower margin of the shelf. This latter hypothesis was reinforced by the work of Andersen and Matthiessen (1967) who showed that increasing mitotic activity was an important factor contributing to the overall rise in tension of the shelf tissues. Verrusio (1970) proposed that a gradual decrease in the angulation of the cranial base could provide the "internal shelf force." It is likely in a multifactorial system such as palate closure that interference with the cranial base, be it mechanical or biochemical, will contribute to failure of palate closure.

Small palatal shelves may also contribute to palatal clefting; X-irradiation produces reduced mitotic activity and small palatal shelves in both rodents and primates. Other teratogens, including glucocorticoids, have been shown to do likewise. Mesenchymal deficiency, however it may arise, will obviously affect the developing palatal shelf mechanism with consequences leading towards malformation.

The role of the tongue in palate closure is still a matter for debate. Complete tongue obstruction over a time-specific period can produce 100% cleft palate in rodents, accompanied by a high proportion of moulding defects of the Pierre Robin type when induced by amniocentesis (Poswillo & Roy 1965).

Harris (1967) has shown that glucocorticoids produce oligohydramnios in mice, with postural-type defects of the palate caused by interference with angulation of the cranial base and subsequent tongue withdrawal. The role of corticosteroids in the induction of cleft palate is still not clear. . . . It has often been demonstrated that pregnant mice exposed to starvation, noise, cold or transportation near the critical time for palate closure will have a high incidence of cleft palate in their offspring.

Disturbances of fusion are believed by Smiley (1972) to be responsible for cleft palate. . . .

Submucous cleft palate, in association with bifid uvula, is likely to be a microform of posterior cleft palate. Submucous cleft palate can be induced in the mouse by the administration of phenobarbitone on Day 12 of development. It results in a delay in the centripetal flow of palatal shelf ossification of increasing magnitude from before backwards, which leaves an unreinforced palatal vault prone to rupture under growth traction or tongue pressures. The absence of bone reinforcement across the midline of the vault, combined with a deficient osseous inductive force in the midline of the palate, contributes to the failure of the velar mesenchyme to merge and elongate. Thus bifid uvula, either alone or combined with submucous cleft
palate, may result from disturbances in the processes of ossification and merging which take place between the seventh and tenth weeks of human development.

SMILEY

Gary R. Smiley, research orthodontist at the University of North Carolina at Chapel Hill, who raises ringneck doves as a hobby, worked as a laboratory technician with an embryologist during the summer of his freshman year in dental school. After graduate training in orthodontics he was invited by D. W. Warren to join the University of North Carolina Oral, Facial and Communicative Disorders Program and was thus provided research time for study of the secondary palate. He began work with anatomist A. D. Dixon and from him learned electron microscopy, which aided his investigation of palate fusion. He noted that, as the palate halves come together, the epithelial edges at their union must break down as nasal and oral accumulation of epithelial cells with lysosome bodies gives way by lytic activity to allow mesenchymal union across the midline. The epithelial plate, which is four to six cells thick at time of contact, separates the approaching mesoderm and, by degeneration and desquamation, goes to one-cell thickness at the presumptive area of fusion.

It does not take contact to cause this epithelial breakdown. Smiley notes that epithelial death is programmed before contact, so if timing is off for any reason, the keratinized edges of the cleft will not join each other. If, for instance, the palatal plates are late getting up to their horizontal position, programmed epithelial death along the cleft edges may proceed according to its own schedule, but it will be too late for union to be achieved by the time the palatal halves actually touch each other.

In 1968 M. Pourtois ascertained that

Fusion of palatal processes is time-critical. That is, if the palatal shelves meet after the critical period for fusion, fusion will not take place.
In 1972 Smiley noted:

Studies which indicate that the soft palate forms by a process of merging could easily explain the occurrence of a bifid uvula, but cannot explain the typical submucous cleft (which has an intact oral and nasal epithelium covering, muscle failing to reach the midline of the velum and usually a deficiency of bone at the posterior border of the hard palate). . . . There is no satisfactory single explanation for the etiology of the submucous cleft, or even for all clefts of the secondary palate. Nevertheless, an abnormal epithelial seam either in its formation or breakdown seems to be a most likely explanation for submucous cleft palate.

In the *Archives of Oral Biology* Smiley noted in 1975:

There are many studies on the midline epithelial seam during palatogenesis but few have distinguished between the presumptive hard and soft palates. Burdi and Faist (1967) and Burdi (1968) in man, and Bollert and Hendrickx (1971) studying baboons, described the development of both the hard and soft palate suggesting that the soft palate develops by mesenchymal merging rather than fusion because epithelial remnants are not found in the soft palate. However, Shah and Chaudhry (1974) indicated that the soft palate in hamsters formed by the process of fusion of the opposing epithelia. This inconsistency and lack of studies on soft palate formation in mice prompted this investigation on normal palatogenesis to determine whether the soft palate forms primarily by epithelial adherence and mesenchymal fusion or by merging.

He concluded:

A midline seam of epithelium was observed in the region of the future soft palate [in rodents and man for a relatively short period of time] indicating that epithelial adherence and mesenchymal fusion was occurring, and not merging. Epithelial breakdown was more rapid and complete in the presumptive soft palate and along the junction of the nasal septum and palate than in the midline of the future hard palate.

In his 1975 histological study in *Archives of Oral Biology* Smiley presented some convincing microscopic sections of human fetuses with and without the midline epithelial seam.
"Human 10-week foetus. (A) Future hard palate—midline epithelium is intact except for early breakdown nasally and epithelium is present between the nasal septum and palate. Note glossopalatine epithelium adherence and partial separation of the nasal septum from the palate. (B) Future soft palate—midline epithelium is present and appears to be in clumps in some areas."

"Human 12-week foetus. (C) Potential hard palate—midline epithelium is intact near the oral groove and has broken down nasally. Epithelium between the nasal septum and palate is absent. (D) Potential soft palate—midline epithelium is absent and the uvula has a furrow."

Based upon these observations . . . the hypothesis is proposed that the medial palatal epithelium is different and/or is acted upon differently in the anterior and posterior regions of the developing secondary palate. . . . Besides the palatal epithelium covering the oral and nasal surfaces, the hard and soft palate oral epithelium itself is different. . . . Differential development also occurs in the underlying palatal mesenchyme, e.g., bone forms in
the hard palate and muscle in the soft palate. The palatal mesenchyme that
develops into these different tissues could significantly influence the midline
epithelium of the respective regions, suggesting that the difference in
epithelial breakdown may not reside in the epithelium per se.

IN VITRO STUDIES OF PALATAL DEVELOPMENT IN MICE

Information on the embryological development of the palate is
being gleaned from laboratory studies, and, of course, even
greater knowledge will eventually be gained from such investi­
gations.

Comparison of secondary palate development with different in
vitro techniques, reported by Gary R. Smiley and William E.
Koch in 1975, suggest:

The mesenchyme may play an important role in epithelial degeneration
along the medial edge of palatal processes, since epithelial disruption did not
occur in the absence of a viable underlying subjacent palatal mesenchyme.

Mary S. Tyler and William E. Koch of the University of North
Carolina School of Medicine found that palatal processes removed
from 12-day mouse embryos under particular culture conditions
were able to continue their differentiation. The discovery enabled
these researchers to make certain interesting deductions.

1. They confirmed the assumption that the epithelium at the
tip of the vertically oriented palatal process was indeed the future
medial epithelium of the horizontally positioned process because
"it was always this epithelium at the tip of the vertical process
which underwent regression."

2. Their results also confirmed for 12-day palatal processes the
1972 report by Smiley and Koch for 14-day mouse palates that
"cellular contact between palatal processes is not a prerequisite
for midline epithelial disruption."

3. They clarified the probability that "from the time it be­
comes identifiable as two ridges projecting from the maxillary
arch, the mouse palate is capable of in vitro development and
eventual fusion."
4. Finally, as suitable in vitro environmental conditions may be provided which are fully adequate for supporting morphogenesis and histogenesis of early palatal tissues, "it seems appropriate to suggest, therefore, that the concept of the 'acquisition' of a 'potential for fusion' does not identify a specific in vivo period of differentiation in the ontogeny of the mammalian secondary palate."

The administration of excess vitamin A to pregnant laboratory animals has been used extensively to produce a high incidence of cleft palate in offspring (A. Giroud and M. Martinet; H. Kalter; D. H. M. Woollam and J. W. Millen). Explanations differ, however, as to how maternal vitaminosis A leads to fetal cleft palate. Ravindra Nanda, formerly of the University of Nymegen, the Netherlands, and now at the University of Connecticut, Hartford, reported in the 1974 *Cleft Palate Journal* that his recent studies suggest:

Vitamin A retards the growth of the palatal process in vivo and subsequently the processes do not come in contact with each other at the morphogenetically determined time. The growth of the head subsequently moves the processes apart and fusion does not take place. However, the palatal processes retain their potential to fuse in vitro in the absence of cranio-facial structures and maternal metabolism and environment. This further suggests that vitamin A probably does not irreversibly disturb normal in vivo events of fusion mechanism.

Of course in vitro studies in the human are more enlightening since there are variations from development of the rodent primarily related to differences in behavior of the epithelium and the area of fusion.

Alastair N. Goss of Adelaide, South Australia, noted in the *Cleft Palate Journal* in 1975:

Only foetuses obtained by open surgical methods are suitable for palatal culture.

His five successful human cultures indicated that it is possible to stimulate in vivo fusion and in vitro epithelial pure formation and to investigate aspects of postfusion rupture. His case I demonstrated that in vitro fusion of human palates does occur,
the fused area showing rapid mesenchymal penetration. Cases III and IV demonstrated that if the intact palate is ruptured, normal healing by epithelial covering of the exposed mesenchyme occurs. As rupture of the previously fused palate was postulated as a mechanism of cleft palate in humans by H. Kitamura in 1966, Goss is in the process of showing that cleft palate can be induced in vivo in the rat by rupture of the intact palate. He reported:

With some types of palatal rupture continued growth of the face distracts the ruptured palate, thus increasing the width of the cleft. Other sites and sizes of palatal rupture heal with time so that the palate has reformed by birth.

Mark W. J. Ferguson of Queen’s University of Belfast (center of the troubled zone), who is interested in philately and paleopathology, has studied normal Wistar rat fetuses and those with cleft palate induced by 5-fluoro-2-desoxyuridine to elucidate the mechanisms of palatal shelf elevation and the pathogenesis of cleft palate. In 1977 he wrote:

The following theory is advanced to account for shelf elevation. The gradual build up of mucopolysaccharides, predominantly hyaluronic acid in the palatal shelves from day 14 to day 16.3 produces an increasingly powerful elevating force because of the turgor associated with the strong water binding tendencies of these substances. At 16.3 days this turgor reaches a threshold level and the elevating force becomes sufficient to overcome the resistance offered by the tongue, so enabling lip up to occur. The tongue is passively depressed, flattened, and its tip protruded out of the oral cavity, so making room for the common nasal passage. Other factors aid the transposition of the palatal shelves. Firstly, the undercutting of the underside of the shelf base by epithelium provides a fulcrum for shelf elevation. Secondly, maxillary and palatine osteogenic blastemata are present just exterior to the shelves and afford a firm base for lip up. The subsequent rapid invasion of the elevated shelves by these blastemata, and the ensuing ossification, soon consolidate the elevated palate.

The present theory of shelf elevation postulates a confrontation between shelf elevating force and tongue resistance, and so it is not surprising that depression of the tongue should lead to premature shelf elevation (even at 14 days). It follows that cleft palate is theoretically producible in at least two ways: (1) by decrease in shelf force (as in F.U.D.R. fetuses); (2) by increase in tongue resistance (as seems probable in Pierre Robin-like anomalies

The avoidance, at least during the first twelve weeks of pregnancy, of drugs known to depress mucopolysaccharide synthesis is recommended.

In 1978, as the Winston Churchill Fellow lecturing at the University of Miami School of Medicine, Ferguson added:

The posterior one-fifth of the palatal shelves (i.e., the future soft palate) are horizontal from their first appearance at day 15 and so do not have to elevate. Furthermore these "soft palate shelves" do not approximate each other till day 17.5, whereas the future hard palate shelves have fused within five hours of flip up (which occurs at day 16.4). . . .

All the F.U.D.R. induced abnormalities are readily explicable by depressed mucopolysaccharide synthesis and it is interesting to note that cleft palate in man is frequently associated with such anomalies. . . .

**OSSIFICATION CENTERS OF THE MAXILLOFACIAL REGION**

According to Patten,

The primary support of the mandibular arch is Meckel’s cartilage, which appears late in the seventh week. By the early part of the eighth week the mandibular bone starts to be intramembranously formed as a number of trabeculae lateral to Meckel’s cartilage. As ossification spreads, the newly formed mandibular bone tends to enclose Meckel’s cartilage.

The maxilla also appears early in the eighth week as intramembranously formed trabeculae in the mesenchyme of the maxillary process. It expands rapidly, but its extensions into the palatal shelves do not ordinarily appear until toward the end of the eighth week when the palatal shelves have moved up from their initial position on either side of the tongue. During the ninth week ossification progresses rapidly, and by the end of the tenth or beginning of the eleventh week, trabeculae extending from the primary ossification areas of the maxillae have laid the foundation for the bony support of the hard palate.

The more medial portion of the maxillary arch which carries the incisor teeth arises, during the late eighth or ninth week, from separate ossification centers formed in the part of the upper jaw which is of nasomedial origin. This independent origin of the incisive portion of the human maxilla emphasizes its homology with what, in lower forms, is a separate bone known as the premaxilla. . . .
The cartilage primordia of the nasal septum and the nasal capsule are clearly differentiated by the end of the seventh week (embryos of 18 to 20 mm. C-R). The paired ossification centers for the vomer appear on either side of the lower part of the cartilaginous septum toward the close of the eighth or the beginning of the ninth week (embryos of 28 to 32 mm. C-R). By the eleventh week the two ossification centers are united below the septal cartilage. A week later the progress of ossification extends so that the periosseum of the vomer merges with that of the palatal bones just above their meeting with each other in the midline.

Here are schematic diagrams showing in the horizontal plane the changing relations at lip level in the developing upper jaw. (From Patten, Normal Development of the Facial Region, in Pruzansky's Congenital Anomalies of the Face and Associated Structures.)

As noted by Patten:

The youngest stage represents relations at the level of the originally shallow stomodeal depression before the rupture of the oral plate. The extent to
which the stomodeum is overhung by the frontal area is indicated by a broken line. . . . The downward component of the growth, which is particularly active in the nasomedial processes, soon brings them into the plane of section. Their union is normally a matter of merging rather than of fusing . . .

Of basic importance in understanding the development of the maxillofacial region are the relationships of the nasomedial processes. Their merging in the midline is readily seen in face views. . . . Their deep relations to the nasal septum are best seen when the developing upper jaw is looked at from below. In such views the deep continuity of nasomedial processes with the primordial nasal septum is clearly evident. Because these primordia lie at slightly different levels, this important relationship can only be suggested in diagrams of horizontal sections at the level of the upper lip by dotting in the position of the nasal septum, as has been done in [the accompanying diagrams].
2. Anatomy of the Palate

**Bony Skeleton**

The bony skeletal scaffold for the palate consists of the bones adjacent to the base of the skull, including the sphenoid and temporal, the premaxilla, the maxilla proper, and the palatine bone. These bones offer the origins and insertions of the muscles and provide the exits of the nerves and blood vessels serving the palate.

These bones, of course, are covered with a periosteum before receiving the palatal muscles and aponeurosis. The entire area is covered finally with a mucous membrane. In the hard palate area the mucosa is grayish pink and tightly adherent to the perios-
teum. The mucous membrane of the oral surface of the soft palate is highly vascular and red in color, covered by a non-keratinized, stratified squamous epithelium. A layer of elastic fibers separates the lamina propria from the submucosa, which contains many mucous glands. At the free border of the soft palate, the oral mucosa changes to pseudostratified, ciliated, columnar epithelium of nasal mucosa.

**PALATAL MUSCULATURE**

Gustavo Sanvenero-Rosselli of Milan, a historical scholar who accumulated an extensive plastic surgery library, reminded cleft specialists at the 1973 Copenhagen International Cleft Palate Congress that Leonardo da Vinci understood the function of the soft palate in using vowels in speech and was cognizant of the varying levels attained by the palate during speech.

The first true anatomical descriptions of normal anatomy of the palate and pharynx were published by H. von Luschka in German in 1868.

**Veau**

Victor Veau of l'Hôpital des Enfants Assistés, Paris, published his classic book, *Division Palatine*, in 1931. Here he described the anatomy and pathology of cleft palate, gleaned from his vast number of cases and his hundreds of surgical procedures. In an explicit diagram of the palatal anatomy, he compared the normal aponeurosis and musculature with that in a cleft palate, showing some of the displacement and misdirection of fibers. One of his important contributions in palate surgery was the metallic suture used in gathering the fibers of the displaced muscles of the cleft edges parallel to each other.

**Whillis**

In 1930 anatomist James Whillis of Guy's Hospital, London, showed that some fibers of the superior constrictor were inserted into the palatal aponeurosis and constituted a lamella he referred to as the "palato-pharyngeal sphincter." It is possible in the
normal palate that Whillis' lamella may narrow the lateral pharyngeal recess, thus helping obtain ultimate palatal occlusion of the nasopharynx during contracture of the levator.

Browne

In the December 1935 *British Medical Journal* the eccentric, innovative Denis Browne of the Hospital for Sick Children, Great Ormond Street, London, postulated an orthopedic operation for cleft palate, justifying his design by his evaluation of the muscular activity during nasopharyngeal closure. He diagramed two overlapping muscle slings involving the levator palatini and the superior constrictor and noted the efficiency of this sphincteric action, which avoids the necessity for the large amount of contraction required by a simple, single muscle ring sphincter.

Oldfield

In 1941 Michael Oldfield of the General Infirmary at Leeds, England, noted that the muscular elements of the soft palate, apart from the uvular muscle, consist essentially of four slings. These are actually bilateral muscles which effect the sling-like function through their common insertion into the tissues of the soft palate. Superiorly, these muscles are the levator and tensor palatini; inferiorly, they are the palatoglossus and palatopharyngeus.
Braithwaite

Fenton Braithwaite of Newcastle upon Tyne received his master’s in mathematics at Cambridge prior to his study of medicine and training with McIndoe at East Grinstead. He collected such exquisite antiques that it has been said his furniture was either just coming back from or just going off on loan to the Victoria and Albert Museum. Braithwaite was the first to realize the importance of correcting the malposition of the levator muscle in cleft palate surgery.

At the 1964 Cleft Palate Congress in Hamburg, Braithwaite noted:

Of the four muscular slings [of Oldfield] ... the levator descending on each side and passing downwards and forwards and the palatopharyngeus passing upwards and forwards, are more intimately concerned with speech.

He presented a diagram of the anterior view of the normal upper levator and lower palatopharyngeus muscle slings (heavy line) and the superior constrictor (fine line) from its attachments at the base of the skull to the hamulus and pterygomandibular raphe. He explained:

The levator sling elevates the soft palate in a backward and upward direction whilst the palatopharyngeal slings on contraction will approximate the posterior faucial pillars and narrow the pharyngeal aperture. When these two slings act together, each loop will afford counter purchase for the other and the interposed palati steadied by simultaneous contraction will convert each group into a "V," and the whole mechanism partakes of the features of an "X," as suggested by Podvinec (1952).

When this mechanism is examined from an anterior view through the open mouth, it may be seen that an isthmus is produced at the level of the soft palate by pulling in the lateral walls of the pharynx. It is obvious, therefore, that if the slings are not intact or indeed if the soft palate is scarred, this will not be effected.

As early as 1949 Braithwaite advocated constructing the levator muscle sling.
Energetic Otto B. Kriens, professor of plastic and maxillofacial surgery, Bremen General Hospital, Germany, started his training in cleft lip and palate in 1963 under Karl Schuchardt in Hamburg. This was like commando training for combat because his teacher was a taskmaster whose students had to be strong to survive. I once heard Sanvenero-Rosselli refer affectionately to his friend Schuchardt as "der Führer." The pressure pushed Kriens into the study of palatal anatomy, and this is what he wrote to me in 1973:

When I started to study the anatomy of the palate, astonishingly there was hardly any literature on the cleft velum! Although the first reports about veloplasties date back prior to 1820, the first detailed anatomic descriptions of the normal anatomy of the palate and pharynx were given by Luschka in 1864. Thus the beginning of cleft palate surgery had to be without knowledge about the pathology to be corrected. No wonder the operations were morphological ones and in all methods the velar halves were used as entities, as architectural units, which had to be moved medially and/or dorsally so to achieve integrity.

Veau had postulated a closure in layers and he drew sketches of what he had seen during interventions. Braithwaite followed Veau's principle even further and dissected "muscles," apparently not exactly knowing which were where.

The dissections I did on normal palates and pharynges trained my three dimensional perception but did not reveal the essential pathology. Thus Professor Schuchardt was not wrong in rejecting an article speculating what seemed to be wrong in the velum. His dissent was not too polite, which probably prompted Professor V. Karfik to spontaneously invite me to Prague for an anatomical study (1966), which revealed characteristic findings (O. Kriens, Anatomische Untersuchungen am gespaltenen weichen Gaumen. *Chir. Plast. Reconstr.*, 1967). The necessary changes of the velar closure were only too evident after the pathology had been exposed to sight!

Here is his 1967 diagram of the dissected soft palate from the oral aspect:
Also shown are two of his actual dissections with labels:

(1) Total bilateral cleft; fresh specimen. On the right can be seen the pars palatina/palatopharyngeus with its insertion on the posterior edge of the palatine bone, as well as the pars pterygopharyngea with its insertion on the hamulus, continuing to the aponeurosis. Between these, the belly of the levator is visible. (2) Total bilateral cleft; material fixed for some weeks in 10% formalin. On the left side of the specimen the levator belly with all its insertions is dissected and the pars palatina of pharyngeus, freed from its hard palate insertion, has been turned laterally.

In _Plastic and Reconstructive Surgery_ in 1969, Kriens summarized the pathology of the cleft palate anomaly as the basis for planning reconstruction.

1. The forward and transverse displacement of muscular insertions (but the origins are normal).
2. The synergistically interwoven anterior portions of the levator veli palati and of the longitudinal portion of the palato-pharyngeal muscle (Veau’s cleft-muscle).
3. The palato-salpingeal fascia forming a functional boundary between the constrictor pharyngeal and palato-pharyngeal muscles (levator space of cleft palate).
4. The plane of loose connective tissue between the palato-pharyngeal sphincter and the palato-salpingeal muscle (plane of blunt dissection in the velum proper).

5. The altered insertion of the hypoplastic horizontal (palatine) tendon of the tensor veli palati (no aponeurosis in the cleft velum).

His explicit drawings, presented in the *Cleft Palate Journal* in January 1970, show the normal palate, the basic pathology of cleft palate and the ideal goal of corrective surgery:

A and B show the normal condition of the three main muscle slings posterior to the interhamulus disk and palatal apron. C presents the levator palatini and palatopharyngeus muscles of the normal soft palate (arrow) in repose and contraction. D presents the levator palatini and palatopharyngeus muscles of cleft soft palate in repose and contraction. E portrays Veau's cleft muscle. F shows the major portion of Veau's cleft muscle being joined to form the levator sling.

Always interested in controversy, I asked David Dickson to review Kriens' outstanding 1967 article. These are his 1976 comments:
His statement that the tensor attaches to the Eustachian tube cartilage is debatable, if one views the literature, and probably wrong. The lack of aponeurosis in the cleft velum is a consistent finding of other investigators, but one in which we do not concur, based on our own histologic sections. His statement that the uvulus muscle is not involved in velopharyngeal closure is without support and is very likely wrong.

DIVIDENDS OF MODERN RESEARCH

Closure of palate clefts has been in progress for over two centuries, and with reasonably good functional results in a majority of cases during the last half century. Yet only in the last few years has the sophisticated knowledge of palatal anatomy and physiology been clarified to the extent that the plastic principle “return normal to normal position and retain it there” has finally been appreciated and applied to cleft palate surgery.

Velopharyngeal function, as its name implies, is a combination of movement patterns of the velum and of the pharynx. The principal components of the velum are a single intrinsic muscle, the insertions of several extrinsic muscles, a large amount of glandular material in the anterior inferior portion of the velum and an anterior aponeurosis. The single intrinsic muscle is the azygos uvulae. Muscles typically referred to as extrinsic muscles of the velum include the tensor veli palatini, levator veli palatini, palatopharyngeus, palatoglossus, and fibers of the superior constrictor. Pharyngeal muscles usually described as having a functional role in velopharyngeal movement include the superior constrictor and the salpingopharyngeus. Research over the past 40 years presents us with a view of the anatomy and physiology of this system which is frequently at variance with descriptions found in modern textbooks and old wives’ tales.

Dickson

As a guest speaker at the Ohio Valley Society of Plastic and Reconstructive Surgery in 1970, I was impressed by a presentation on “New Studies on Velopharyngeal Musculature” by David Ross Dickson, professor of anatomy and speech at the University of Pittsburgh. Dickson, dedicated, sensitive, tireless, is a teacher who chose speech pathology because of a long-standing interest
in human communication. He has an inborn quirk that compels him to attack ideas simply accepted, without reason or because of tradition. He believes in the scientific method, not just as an exercise in academia, but also in personal conduct, social rules and political viewpoints, searching to know the “real question” and considering unconsidered options. Yet he can be found in all weather collecting English brass rubbings, made by a technique developed in eleventh-century Netherlands, atop famous British sarcophagi, such as those of Sir Thomas Bullen, father of Anne Boleyn, Lady Margaret Chayne, and especially the Black Knight of Canterbury.

In 1972 Dickson was invited to Miami to lecture and at that time helped place the palatal muscles in plasticine on the base of a skull. Now, as professor of pediatrics at the University of Miami School of Medicine and director of speech and hearing at the Mailman Center for Child Development, he will describe the current knowledge on the palatal musculature with its variations from the previous standards in *Gray's Anatomy* and even in *Cleft Lip and Palate*, published in 1971. The accompanying drawings were made from dissections, aided by the microscope, of embryonic heads by Wilma Maue-Dickson, previously of the University of Pittsburgh and now associate professor of anatomy at the University of Miami School of Medicine.

Comparisons of muscles of all the usual types of clefts in 18 mature stillborn children with those of four normal stillborn children have been obtained from Miroslav Fára's and Jiří Dvořák's dissections at the Charles University, Prague.

Dickson will describe muscles in the normal palate; Fára and Dvořák, muscles in cleft palate.

*Dickson:*

The *tensor veli palatini muscle* arises from the angular spine of the sphenoid bone, the scaphoid fossa, and the pterygoid fossa. Medial to these attachments, fibers of this muscle arise from the lateral membranous wall of the Eustachian tube. These fibers converge on a medial tendon which passes around the hamulus of the medial pterygoid plate. At this point the tendon is covered with a synovial sheet. The tendon then bends into a horizontal plane and enters the velum as the anterior aponeurosis, which is composed of a flat tendinous sheet in the anterior third of the velum, superior to the
glands and muscles which are found in that portion of the velum. It has been thought that since the notch of the hamulus through which the tendon passes is slightly inferior to the velum, muscular contraction of the tensor palatini muscle would place tension on the velar aponeurosis. There is no evidence whatever that such tension exists as a function of contraction of this muscle. Nor is there any convincing evidence that tension placed on the aponeurosis would have any particular functional significance. It has been well documented, however, that this muscle, upon contraction, opens the Eustachian tube, and that no other muscle serves this function. In 1862, Henle disclosed that the tensor palatini muscle exerts a force predominantly effective on the auditory tube with only a minor part of its activity directed to the normal palate. In 1923, Rich confirmed this in dogs and in 1964 Ruding claimed that the tensor palatini muscle had only an auditory function in the cleft palate. It is interesting to note that the superior part of the tensor palatini muscle forms a tendon which passes through the cranial base and forms the inferior tendon of the tensor tympani muscle, the other end of which attaches to the malleus. Thus these two muscles, the tensor tympani and the tensor palatini, form a two-bellied muscle. There has been speculation that these two muscles may have a conjoint function in aeration of the middle ear; the tensor veli palatini by opening the Eustachian tube, and the tensor tympani by increasing middle ear pressure by drawing the tympanic membrane medially, which would, in turn, possibly lower the threshold for Eustachian tube opening. This speculation has arisen from the evidence that three factors are necessary for Eustachian tube function. The first is contraction of tensor palatini muscle, the second is production of surfactant to release surface tension within the Eustachian tube, and third is air pressure differential between the middle ear and pharynx.

**Fára and Dvořák:**

The tensor [in the newborn cleft] was somewhat thinner than in a normal newborn child . . . [with] a few bundles attached to the hamulus and the tendon itself . . . The front part of its bundles extended along the rudimentary palatine aponeurosis, toward the posterior nasal spine, and was partially attached to the spine or (laterally) to the posterior edge of the palatine bone. Some of the tensor fibers radiated into the aponeurosis. The main part of the tendon, however, arched backward to the cleft edge of the velum . . . [and thus became either] partly dispersed, and then a triangular area passed into the front bundles of the levator muscle, or [in two-thirds of the autopsies] . . . not disperse [d] at all, but passed into the anterior bundles of the levator muscle as . . . a thick and free single muscular-tendinous bundle.
APONEUROSIS IN CLEFT PALATE

This is one area where Veau, Fára and Dickson have some disagreement. As indicated by Veau in *Division Palatine* (1931), the classic schema of the normal palate described by Fára consists of an anterior third (aponeurosis), a middle third (muscular) and a posterior third (mucous membrane). Veau stated:

In cleft palate, the anterior third (aponeurosis) is lacking and there remains only a solid fibrous fasciculus for the aponeurosis; this fasciculus is attached to the bone. *There is no real palatine aponeurosis in the palatine division* [in cleft palate].

In 1970 Miroslav Fára and Jiří Dvořák discussed the deficiency of the palatine aponeurosis in the cleft palate. They wrote of the tensor veli palatini muscle:

It has no proper chance to function fully; thus, it does not develop as it should. The absence of a fixed point in the midline (which is necessary for the insertion of the fan-shaped tendon) causes not only an incomplete and atypical growth of the tendon itself, but a marked hypoplasia of the palatine aponeurosis as well. Indeed, the very existence of this aponeurosis is due to the extension and penetration of the tensor tendon into it. Thus, the very aponeurosis in its lateral area is now very short; as it approaches the cleft margin, it practically disappears.

David and Wilma Dickson of the University of Miami take a different stand and present microscopic sections of a fetus with cleft palate which clearly demonstrates the palatal aponeurosis.
Dickson:

The levator palatini muscle is a cylindrical muscle which has its origin from the petrosal portion of the temporal bone anteromedial to the entrance of the carotid canal. From that point the muscle courses inferior to the Eustachian tube and occasionally gives off a few fibers to the cartilaginous wall of the tube. Just before entering the velum, the muscle passes lateral to the torus tubarius, which is the enlarged inferior end of the Eustachian tube cartilage. From that point the muscle passes into the soft palate with fibers spreading over the posterior three-fourths of the velum. These fibers cross toward the midline where they join with fibers from the opposite levator palatini muscle. Within the velum the levator palatini muscle is the most superior muscle with the exception of the azygos uvulus.

The levator palatini muscle displaces the velum in a superior and posterior direction. The left and right levator muscles form a sling widely separated superiorly and interlacing in the velum inferiorly. From studies of this muscle it is probable that the course of the muscle from velum to cranial base is in a direct line with motion of the velum toward velopharyngeal closure for speech.

Fára and Dvořák:

[In the newborn cleft this muscle was] considerably hypoplastic bilaterally; sometimes, [it] did not exceed half the muscle thickness in normal newborn children. The thinner the muscle belly, the thicker the layer of loose connective tissue in its bed [Veau, 1931]. . . . The posterior bundles ran posterolaterally toward the . . . palatopharyngeus, penetratin[ing] the posterior palatine arch [near] the base of the uvula. . . . The medial bundles radiated like a fan into the margin of the cleft. The anterior bundles were either . . . attached by a triangular tendinous area coming laterally from the posterior nasal spine to the posterior edge of the palatine plate (. . . [and also] into the tensor tendon), or . . . directly linked up with the compact part of the tensor tendon. . . . In the less serious forms of clefts . . . some anterior bundles of the levator advanced for some millimeters along the cleft margin of the palatine plate as a part of Veau’s "cleft muscle."

Dickson:

The palatoglossus muscle is slender and arises from transverse bundles of the tongue. It passes through the palatoglossal arch and into the inferior middle portion of the velum. It would appear capable of lowering the velum or raising and retracting the tongue. However, electromyographic evidence suggests that the palatoglossus muscle is active in tongue function but not in velar lowering. It may also act to narrow the opening between the mouth and pharynx during swallowing.
Fára and Dvořák:

[This muscle in the newborn cleft] passed [forward] in the cleft margin to the posterior edge of the palatine plate . . . [and] extended, in many cases, beyond the posterior edge . . . [to become] inserted more frontally (3 to 5 mm) in the oral peristeum of the hard palate.

Dickson:

The palatopharyngeus muscle arises from the lateral and posterior pharyngeal walls and inserts into the velum. Its superior fibers arise from a complex intermingling with the superior constrictor muscle. These fibers arise from a level just below the most superior fibers of superior constrictor and pass horizontally into the posterior three-fourths of the soft palate, inferior to the fibers of the levator palatini muscle. Lower fibers of the palatopharyngeus muscle arise from the inferior part of the lateral wall of the pharynx, medial to the middle and inferior constrictor muscle. Some fibers may arise from the thyroid cartilage. These lower fibers pass through the palatopharyngeal arch to insert into the velum.

While there is little electromyographic evidence regarding the function of this muscle, it is felt that it decreases the distance between the palatopharyngeal arches during swallowing and also acts to lower the velum.

Fára and Dvořák:

[This muscle in the newborn cleft was] relatively well developed. . . . Even though the smaller part of its fibers ended in the cleft margin, most of its bundles passed forward along this margin and inserted on the posterior edge of the palatine plate. . . . Some fibers advanced along the cleft margin, together with the bundles from the levator as a part of the "cleft muscle." . . . The circular fibers of the posterior pharyngeal wall were difficult to distinguish from the bundles of the superior constrictor. . . . (50 percent of our cases) had condensation and even some thickening of the circular fibers . . . cross [ing] in the Passavant pad, which bulged visibly in the autopsy material. This was not seen in any case of sectioned normal newborns.

The powerful insertion of the pars pterygoidea extended from the hamulus across the medial plate of the pterygoid, as far as the lateral portion of the aponeurosis.

Dickson:

The azygos uvulus muscle is a well-developed unpaired muscle traversing the velum in an anterior-posterior direction superior to all other muscles of the velum. Its origin is apparently from the anterior velar aponeurosis with occasional tendinous fibers passing forward to the posterior nasal spine. It
passes posteriorly through the superior midline of the velum to insert into the uvula.

The function of this muscle has never been studied. However, this muscle is thickest as it passes superior to the main mass of the levator palatini muscle, approximately two-thirds of the way back in the velum from the hard palate. This is the portion of the velum which is most displaced in velopharyngeal closure. During velopharyngeal closure, particularly in the male, the superior surface of the velum become convex from anterior to posterior, creating a considerable hump in the superior portion of the velum above the level of contact of the velum with the posterior pharyngeal wall. This superior hump in the velum has been called the "levator eminence" but is more likely to be created by contraction of the uvulus muscle which could thicken the velum in this area. Therefore, at least until some further evidence develops, it is probably more reasonable to call this area the uvular eminence. This could create some confusion but no more so than is presently available in velopharyngeal terminology.

It is of interest that as early as 1880 R. Falscon commented on the bulk of the musculus uvulae. In 1969 R. Pigott confirmed with nasendoscopy the presence and importance of the musculus uvulae in speech:

The enormous bulk of the musculus uvulae could be seen. The majority of subjects had a large ridge down the soft palate, occupying the central 1/3, rising to a height almost equal to its width. In other subjects, it was less prominent, but it was never absent. . . . During speech movements . . . the levator sling could be seen to tighten into a bar throwing the convexity of the musculus uvulae bulge up and back to fit into the concavity of the posterior superior pharyngeal wall. . . . The possible role of the musculus uvulae in giving a suitable convexity to the upper surfaces of the levator at the point of contact . . . is of particular importance in the light of Broomhead's finding that this muscle is not supplied by the pharyngeal plexus, but by the lesser palatine nerve.

As part of the fruit from David and Wilma Dickson's research on the morphology of the musculus uvulae, Nabil A. Azzam and David P. Kuehn of the University of Iowa reported their findings, confirming the Dicksons' observations in the 1977 *Cleft Palate Journal*. They noted:

The morphology of the musculus uvulae was studied utilizing detailed gross anatomical dissections and histological sectioning of the soft palate in seven adult human cadavers. The results indicated that the musculus uvulae is paired. . . . Each bundle takes origin lateral to the midline from the
tendinous palatal aponeurosis posterior to the hard palate and just anterior to the insertion of the levator veli palatini muscle. The two bundles converge in an area overlying the sling of the levator muscle and course along the dorsum of the soft palate, terminating as two separate bundles which subdivide and insert between the mucous glands of the uvula proper into the connective tissue and basement membrane of the mucosa. Because of its location and size, it appears that contraction of the musculus uvulae would add bulk to the dorsal surface of the elevated soft palate [arrow], thus aiding in occlusion of the velopharyngeal portal during speech and deglutition.

Fára and Dvořák:

[This muscle in the newborn cleft] passed in the cleft margin and its bundles intermingled with those of the palatopharyngeus and the levator.

A more detailed description of the uvular muscle in cleft palate was given by Elizabeth Ann Latham at the Third International Congress on Cleft Palate in Toronto, based on serial histological sections of two postmortem infants and a Plexiglas reconstruction.

The Musculus Uvulae was divided by the cleft into its bilateral component muscle bundles which were seen on the medial border of each palatal shelf. The M. Hemiuvulae originated anteriorly in relation to the border of the hard palate formed by the palatine bone. Here it blended with other velar muscles. It stayed in the medial border as it coursed posteriorly beneath the mucous membrane and turned more onto the inferior border prior to entering and dispersing in the hemiuvula. A coronal section through the cleft soft palate at the level of the pterygoid hamulus showed the hemiuvular muscle on the medial border of the palatal shelf between the mucous membrane and deeper glandular tissue. This was clearly seen at a higher magnification which showed the muscle fibers sectioned rather obliquely.

PHARYNGEAL MUSCLES

The constrictor pharyngeus muscles consist of superior, medial and inferior portions. The superior portion of the constrictor complex may be involved in velopharyngeal function. The superior constrictor muscle fibers have their origin at the hamulus and the adjacent pterygomandibular raphe. Fibers pass around and through the lateral pharyngeal wall and "join corresponding fibers of the opposite side in a tendinous strip, the pharyngeal raphe, which runs in the midline from the pharyngeal tubercle of
the occipital bone throughout the entire length of the pharynx.” To complete the circle of this “U,” Whillis found that some of the upper fibers inserted into the palatal aponeurosis formed an actual palatal-pharyngeal sphincter. In 1948 Whillis at Guy’s Hospital patiently pointed out to me in detail in cadaver specimens the muscles involved in the “palato-pharyngeal sphincter.” He emphasized the importance of the superior pharyngeal constrictor’s lateral attachments into the soft palate, which he had found in 1936 under Wardill’s none-too-gentle prodding.

Dickson:
While the superior constrictor muscle undoubtedly has an important function in narrowing the pharynx during swallowing, its function in velopharyngeal closure is debatable. While Passavant’s ridge has never been studied electromyographically, it is quite probable that this inbulging of the lateral and posterior pharyngeal walls seen in many patients with cleft palate and other forms of velopharyngeal insufficiency is a function of the most superior fibers of superior constrictor which enter the velum. Some writers have suggested that the superior constrictor is also responsible for the lateral wall motion seen in normal velopharyngeal closure. However, the fact that Passavant’s ridge occurs below the normal site of velopharyngeal closure, the fact that the lateral pharyngeal walls move medially and posteriorly rather than medially and anteriorly in normal velopharyngeal closure and the fact that the superior constrictor lies at the level of the hamulus, rather than higher in the nasopharynx, suggests that it probably is not involved in velopharyngeal function during speech. Available electromyographic evidence supports this contention. The continuing debate regarding the role of this muscle in lateral wall movement during speech has been reinforced by findings of considerable variability in patterns of motion of the velum and pharynx from subject to subject in radiographic research.

The salpingopharyngeus muscle consists of a few fibers arising from the inferior portion of the palatopharyngeus muscle which passes through the lateral pharyngeal wall superiorly to attach to the torus tubarius. These muscle fibers are few in number and frequently absent in normal specimens. Commonly, the salpingopharyngeal fold through which these fibers pass consists entirely of gland and loose connective tissue.

Fára and Dvořák:
Fára noted no difference in the pharyngeal muscles in the newborn cleft and the normal.
Dickson:

In summary, from a functional standpoint it is apparent that the levator veli palatini muscle is the principal and quite possibly the only muscle to function for elevation of the velum in speech. In addition, the medial and posterior motion of the lateral pharyngeal wall during velopharyngeal closure for speech must be accounted for. Since the salpingopharyngeus muscle is frequently absent in the normal, and since the superior constrictor muscle is probably too low to account for motions seen in the nasopharynx, and because available electromyographic evidence is not supportive of the contention that this muscle acts during velopharyngeal closure for speech, some other mechanism must be found. A likely answer is to be found by noting the slinglike arrangement of the entrance of the levator muscles through the pharynx and into the velum. As was noted above, the levator passes lateral to the torus tubarius prior to entering the velum. Thus, on contraction it would be quite likely that the levator muscles would not only lift the velum but would displace the lateral pharyngeal walls and tori tubarius in a medial and posterior direction. It is, therefore, a most reasonable hypothesis that both the pharyngeal and velar components of normal velopharyngeal closure for speech are a function of the levator palatini muscle.

With regard to the cleft condition, here are a few of Fára’s deductions:

The differences between the normal and the cleft arrangement of the muscles of velopharyngeal closure are considerable, but . . . occur because the muscles extending toward the central line of the soft palate cannot attach themselves to the punctum fixum in the midline of the velum; so they insert at some substitute points. These points, however, prevent the muscles from becoming fully functional; therefore, their development is retarded.

With the preservation of normal origins, the atypical insertions and the hypoplasia of the muscles are the main pathological features in the cleft velum . . . .

The levators in clefts illustrate clearly the effect of a morphological disorder on function, not only from the point of view of quantity but also of quality. Indeed . . . the effect of the activity of these muscles in a cleft palate is almost opposite to that in a normal one. While the muscles of both sides normally join in the raphe to form a sling lifting the palate upward, in cleft palates each muscle pulls its own half of the soft palate in an entirely different direction (i.e. supero-laterally), causing a further widening of the cleft.
Robert Shprintzen of Montefiore Hospital, the Bronx, New York, of Spanish descent with a Russian rinse, made an interesting study, with McCall, Skolnick and Lencione.

The frontal and lateral cinefluorographic views of five normal subjects performing speech, blowing, and whistling tasks were synchronized in order to observe where the greatest degree of medial movement in the lateral aspects of the pharyngeal walls was occurring in relation to structures observed in lateral view. The results . . . indicate that for all five subjects, maximal medial excursion in the lateral walls of the pharynx occurred at the level of the full length of the velum and hard palate, well below the levator eminence. It is hypothesized that the observed interaction may be due to the select contraction of those fibers of the superior constrictor muscle which enter the velum via the lateral walls and those fibers attached to the pterygoid plates, as well as levator muscle activity.

This led to their suggestion of the possibility that the kinesiological observations of this study would seem to indicate that both the levator and the superior constrictor are necessary to closure.

Nasopharynx

The pharynx is related to the sphenoid bone and to the basilar part of the occipital bone above, and descends into the esophagus. Anteriorly, it opens into the nasal and oral cavities and the larynx; posteriorly, from before backward, it is related to the prevertebral layer of fascia, prevertebral muscles and upper six cervical vertebrae. Laterally, such structures as the styloid process and its associated musculature, the medial pterygoid muscle, the carotid sheath and its contents and the thyroid gland are present.

The nasopharynx is actually the posterior portion of the nasal cavity communicating with the oropharynx through the pharyngeal isthmus or hiatus and bounded by the palatopharyngeal arches, the soft palate and the posterior wall of the pharynx. Embedded in the mucous membrane of the posterior nasopharynx is the mass of lymphoid tissue known as adenoids. The pharyngeal isthmus is encircled by a lymphatic ring, the nasopharyngeal tonsil (adenoids) above, the palatine tonsils laterally and the lingual tonsils below.
Dissected sagittal view—normal adult palate and pharynx showing auditory tube, pharynx and musculature of the velum (palate).
Inferior view—newborn palate and related structures
Mucosa reflected and palate dissected.
Neurovascular bundle
Levator
Aponeurosis
(mucosa reflected)
Palatopharyngeus
Palatoglossus

CLEFT
Palate dissected to show auditory tube and related structures.
Superolateral view of the palate and pharynx, showing position of auditory tube and the tensor veli palatini, levator veli palatini and superior constrictor muscles.
The triangular pocket in each lateral wall of the nasopharynx is called the tonsil and is formed by the diverging pillars of the tonsil, the anterior pillar formed by the palatoglossus muscle and the posterior pillar formed by the palatopharyngeus muscle. Cradled between the pillars in each fauces lies the palatine tonsil.

The most significant structure in the lateral wall of the nasopharynx is the auditory, or Eustachian, tube.

THE EUSTACHIAN TUBE

Dickson

Wilma Maue-Dickson of the University of Miami School of Medicine, a compulsive, analytical perfectionist, played violin in the Exeter Symphony Orchestra in England, climbed Kilimanjaro, and saw her first severe unoperated unilateral cleft lip while in the Peace Corps in Ethiopia. David Dickson was her major professor in head and neck physiology at the University of Pittsburgh. Their mutual love of teaching, research and human communication overcame this obstacle to their relationship and resulted in marriage. Her compulsion not just to observe craniofacial pathologies but to speed their extirpation was probably "fueled" most effectively the day she walked into the storage room for some 15,000 human embryos and fetuses at the University of Pittsburgh's Cleft Palate Center in 1969 and recognized that a gold mine of information for living children with facial anomalies lay in that 15' X 15' room.

Since then she has carried out numerous microscopic dissections of fetal heads which have placed her among the foremost head and neck anatomists. She has a special affection for the Eustachian tube. This is her 1976 position:

In the sixth century B.C., a man named Alcmoeon became interested in how goats "breathe through their ears" and gave us our first description of the structure of the auditory tube, which he felt served this function (Macbeth, 1959). Later, during the sixteenth century, the tube was described in further detail by the Italian anatomist, Bartolomeo Eustachio, for whom the tube was named. He was one of the first to describe accurately its structure, course, and relations. He compared the tube to a quill pen and divided its bony and cartilaginous parts, but did not hazard a guess as to its function.
The anatomy of the adult auditory (Eustachian) tube has been carefully documented, as has its histology, and large strides have been made in our understanding of its embryologic and fetal development. It courses from the nasopharynx to the middle ear in a posterior lateral superior direction. The anteromedial two-thirds of the tube, called the cartilaginous portion, consists of a superomedial cartilaginous wall and an inferolateral membranous wall. The posterosuperior one-third of the tube passes through the petrous portion of the temporal bone and is referred to as the osseous portion, protympanum, or semicanal. The division between the cartilaginous and osseous portions is marked roughly by a constriction called the isthmus.

It has been well documented (Sucheston and Cannon, 1971) that the membranous part of the tube is lined with pseudostratified, ciliated, columnar epithelium, while the medial lamina and roof are lined with cuboidal epithelium. Muco-serous glands and goblet cells are present at the pharyngeal orifice and in the mid-portion of the tube, but are absent at the tympanic orifice. Lymphoid tissue is present at both orifices but is far less abundant in the mid-portion of the tube.

The auditory tube is of particular interest because it provides a dynamic link between the nasopharynx and middle ear. The middle ear has no direct outlet via any other route than the auditory tube. The auditory tube, therefore, provides a mechanism whereby pressure can be equalized across the tympanic membrane. The cartilaginous part of the tube is roughly elliptical in configuration and is normally collapsed, but opens during swallowing, coughing and sneezing. The osseous portion is obligatorily open.

The tube is also of clinical interest because it provides an avenue for the outflow of fluids from the middle ear. Unfortunately, it also provides an access route for the spread of infection from the pharynx to the middle ear and mastoid area.

The specific mechanism for opening the auditory tube involves an interaction of muscular force, pressure differential, ciliary action, and possibly the aid of a surface tension-reducing substance such as surfactant. Muscular activity associated with tubal opening has been a source of debate for years. Normal tubal function has been associated at one time or another with at least six different muscles, including the superior constrictor, the palatopharyngeus, the medial pterygoid, the lateral pterygoid, the levator veli palatini, and tensor veli palatini. Of this group, only the latter muscles have direct attachments or important spatial relationships to the tube. Fortunately, this debate about the function of the muscles associated with the auditory tube has been settled by an elegant study conducted by Arnold Rich [experimental pathologist at Johns Hopkins Hospital] in 1920, which indicated clearly that the tensor veli palatini is the sole muscle responsible for tubal opening at the isthmus. More recent EMG studies have supported this fact.
Another debate on tubal function concerned innervation of the tensor veli palatini muscle, which has been variously ascribed to cranial nerves V, VII, X, and XI. However, Rich (1920) demonstrated convincingly that tensor veli palatini is innervated via the mandibular branch of cranial nerve V.

Levator veli palatini may assist in opening the pharyngeal orifice of the tube by moving the torus tubarius, the cartilaginous expansion of the tube at its pharyngeal orifice, posteriorly and medially during swallowing. However, this action would not aid in tubal opening at the isthmus.

Cleft Palate: The auditory tube is of further clinical interest because of its apparent involvement in cleft palate. It has been demonstrated that babies with cleft palate have an almost 100 per cent incidence of middle ear effusion, frequently accompanied by hearing loss. Numerous studies have been conducted to ascertain why this is true; none have completely solved this puzzle, but it clearly involves abnormal Eustachian tube function. A recent anatomical study conducted by Maue-Dickson (1975) indicated that human fetuses with cleft palate consistently show the following characteristics:

As compared to the non-cleft, there are narrower and smaller auditory tube lumina, which are more widely separated than in normals.

The greatly enlarged auditory tube cartilages are also more widely separated than in normals.
There are more widely separated pterygoid plates than in the normals. There is significantly reduced pharyngeal height, but greatly increased pharyngeal width.

One conclusion from these data is that the space between the lateral pharyngeal wall and the side wall of the cranium is substantially reduced and that the tube may suffer a mechanical disadvantage as a result. This problem may be reduced by craniofacial growth, which might relieve stress on the tube. This suggestion is consistent with the observation that children with cleft palate typically have reduced middle ear problems within the first few years of life.

Interestingly, while the interruption of the levator veli palatini muscle and of other muscles which traverse the soft palate is obvious in cleft palate, there is no indication that the extra-palatal anatomy of the tensor veli palatini muscle is abnormal in cleft palate, and even in severe cleft of the palate, the presence of a well-defined palatal aponeurosis (the tendon of tensor) can be demonstrated in the palatal tags in histologic sections.

In summary, while the adult structure of the auditory tube is fairly well understood, more information is needed on the specific morphology of the tube and associated musculature in cleft palate. Based on data collected recently, there is a strong suggestion that cleft palate may in fact co-exist with, or even be caused by, cranial base deformity occurring early in the embryogenesis of the involved structures, and that auditory tube malfunction observed clinically in cleft palate may be related to this deformity.
BLOOD SUPPLY TO THE PALATE

The internal maxillary artery gives off the descending palatine artery, which, in turn, gives off several branches to the tonsils and soft palate. It then passes through the posterior palatine foramen, just above the periosteum, and proceeds forward close to the alveolar margin on each side as the greater (major) palatine artery to the incisive fossa. At that point it sends a terminal branch through the incisive foramen to anastomose with the terminal branch of the sphenopalatine artery. The sphenopalatine artery is also a branch of the internal maxillary artery. One of its branches descends to the incisive canal and anastomoses with the terminal ascending branch of the posterior palatine artery to form the anterior blood supply to the palate. The posterior septal artery arises from the sphenopalatine artery in the roof of the nasal cavity and courses down the groove of the vomer to the incisive foramen. As noted by Brescia, a wide, rich anastomosis is formed between the posterior septal, major palatine and ascending septal branches of the superior labial arteries.

The blood supply to the anterior alveolar process of the maxilla comes from the arterial complex composed of the major palatine, anterior and posterior superior alveolar and branches of the sphenopalatine arteries.

In the complete bilateral cleft lip and palate, as noted by plastic surgeon W. B. Slaughter, along with J. V. Henry and J. C. Berger, the union of the superior labial arteries is lacking; thus they do not contribute to the blood supply of the philtrum. Also absent is the anastomosis of the posterior septal artery with the major palatine artery. Therefore, premaxilla and philtrum must derive their blood supply from the posterior septal artery and to some degree from the lateral and terminal branches of the anterior ethmoid vessels which pass through the columella. Fortunately, in cleft specimens, there is usually one well-developed vessel on either side of the premaxilla in the region where the incisive foramen should have been. Each of these vessels passes anteriorly and inferiorly into the philtrum and forms an arcuate anastomosis across the midline in the inferior part of the philtrum.

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The scholarly plastic surgeon I. W. Broomhead dissected a fetal head for blood supply studies. In 1951, in the *British Journal of Plastic Surgery*, he reported:

The greater palatine artery [GrPalArt] supplies the oral surface of the hard palate and gives off a few fine branches which perforate the horizontal plate of the maxilla to supply the nasal mucosa. It also sends twigs to the gums and palato-glossal arch. The lesser palatine artery [LsPalArt] supplies about the anterior half of the oral surface of the soft palate. A branch of the facial artery, the ascending palatine artery [AscPalArt], is the largest vessel entering the soft palate. It ascends on the lateral side of the superior constrictor muscle to turn downwards and forwards into the soft palate between the tensor [Ten] and levator palati [Lev], giving small branches to these muscles. There are two main terminal branches, the anterior one passing along the anterior border of the levator palati and the posterior one passing through this muscle. On approaching the midline the posterior division turns backwards to run the length of the soft palate to the uvula. Small twigs from the tonsillar [TonsArt] and ascending pharyngeal arteries [AscPharArt] also reach the soft palate. The branches from the tonsillar artery enter along the palato-glossus muscle [PalGloss], and those from the ascending pharyngeal pierce the superior constrictor [SupConst] and pass along the fibres of the palato-pharyngeus muscle [PalPhar].

Broomhead concluded with:

The vascular supply of the soft palate is not endangered by the [standard third-degree cleft palate] operation.

Muriel E. Morley of Newcastle upon Tyne was the speech therapist for many years for Wardill's cleft palate cases. In her little 1962 book, *Cleft Palate and Speech*, she noted:

It is of importance in surgery that the blood supply to the palate enters through the bone and not, as in other parts of the body, through the periosteum. . . . It is therefore possible at operation to strip the periosteum from its bony attachments without interfering with the blood supply.

Stefan Demjen of Bratislava referred to the lack of knowledge of the blood supply to the bony palate:

The hard palate and its mucoperiosteal membrane are supplied by blood from nasopalatine vessels and from the descending palatine arteries. The bony palate is said to have an independent blood supply and is thus protected from necrosis following conventional palate operations.
It is important to know whether the presence of a cleft in the palate changes the vascular arrangement. The data are minimal, but in 1974 David Dickson et al. in their "Status of Research in Cleft Palate" reported:

Blood supply: no specific investigations of the blood supply to the cleft palate have been found except for Frederiks, who reported slight differences between cleft and non-cleft.

Edith Frederiks of Leiden, the Netherlands, did note in 1972:

In the secondary palate the existence or absence of a cleft makes little difference to the vascular pattern.

Yet in the 1973 "State of the Art" report on clinical research in cleft lip and cleft palate, Spriestersbach, Dickson, Fraser, Horowitz, McWilliams, Paradise and Randall proposed the likelihood of a variability in arterial arrangement in cleft and non-cleft humans. This was confirmed when, in 1977, William P. Maher of Marquette University and the Medical College of Wisconsin reported postmortem arteriographic studies of the major branches of the pterygopalatine portion of the maxillary artery in three cleft palate and nine non-cleft near-term human fetuses. The study revealed numerous variations in each facial half in both cleft and non-cleft palates. Maher noted anatomical aspects pertinent to palate surgery:

Lateral branches of the greater palatine arteries provide substantial contributions to all maxillary deciduous and permanent dental structures. Incisions made parallel to the alveolar ridge and lateral to the greater palatine artery are designed for purposes of moving the pedicle flap medially to close the cleft. These incisions completely sever nutritional supply from the palatine network to all the maxillary teeth. However, the developing dental structures are also supplied by dental branches from the superior alveolar artery and gingival-osseous branches from the great facial network. Whether these major contributions are able to provide adequate nutritional sources for normal dental development or whether temporary nutritional loss from the palatine network as the results of sectioning might be responsible for morphological defects in hard dental structures remains to be clarified.

The palatine mucoperiosteum is detached from its bony base in the preparation of a palatal pedicle flap, and as a result the recurrent osseous branches are severed. These branches vary in size, number, location, and
distribution frequency. Bleeding from their cut stumps at the bony surface may be judged . . . insignificant at the time of surgery. However, after the flap is repositioned, should bleeding continue . . . blood may pool beneath the repositioned flap.

Maher also noted:

Terminal branches of the greater palatine artery were found to anastomose variously with: 1) the lateral nasal septal artery, 2) the superior alveolar artery, 3) labial branches of the facial artery via branches of the palatal artery that pass through the maxillary fissure or via the external nares, and 4) with its companion on the contralateral side. One or more combinations of these variations may occur in both facial halves . . . Furthermore, crossover anastomoses between terminal branches of major vessels can occur.

Maher admits to being a two-kind-of-vessel freak:

I have a canoe that is called Capillary, a nice runabout called Arteriole, and a larger boat called Ark of the Aorta.

Since 1957 he has also been involved in microvascular studies and has developed the technique of injecting blood and lymph vessels with India ink in order to examine the routes and distributions. In fact, he became known as the Wizard of Ink or Inky for short. In 1977 he forwarded this vascular maze to me and wrote on the back of it:

This is a photograph of ink replications of arteries and veins in the vicinity of the palatal raphe that has habitually been described as being relatively avascular. The preparation is that of perinatal man.

INVESTIGATION INTO BLOOD SUPPLY TO PALATE BONES

This field has long been the realm of surgery guided largely by the surgeon's supposition. It occurred to me that further study would be of interest, not only from the aspect of safety during surgery, but also for investigating surgery's possible effect on bone growth by reduction in blood supply. Lieutenant Colonel G. Franklin Welsh, U.S.A.F., while in general surgery residency at the Mayo Clinic, visited Miami to investigate a possible residency in plastic surgery. He was challenged to study the blood supply to the bones of the palatal area and to search for and identify blood
vessels that would demonstrate how the oral mucoperiosteum could be reflected with impunity in palate surgery without fear of devascularizing the bony palate. Welsh dissected the blood supply in both halves of a medial-sagittally sectioned head from a cadaver injected with red latex. This was his 1971 report, along with a photograph of the specimen:

Soon after its origin as a terminal branch of the maxillary artery, the descending palatine artery enters a canal in the vertical plate of the palatine bone to give off an intramedullary cascade of arterioles which meander antero-inferiorly into the bony hard palate. Several branches descend through the palatine foramina and divide into an anterior group, the greater palatine arteries, and a posterior group, the lesser palatine arteries, for soft palate. Immediately upon emerging from the greater palatine foramen, these arteries give off multiple small vessels that spread out, closely adherent to the undersurface of the bony palate, yielding several perforators into the bone, rather than lifting away with the mucoperiosteum. Specimen is shown:
bone cortex externally, continues medially beyond the alveolar ridges and tooth sockets into the bony palate.

**Conclusion:** With perforating branches from nasal floor mucosa, multiple intramedullary branches from the descending palatine artery in its canal, and immediate takeoff of bony branches from the emerging greater palatine arteries, the blood supply to the bony palate is well secured even as the mucoperiosteum is lifted, even if the greater palatine artery should be ligated.

Upon receipt of this fine work, I wrote to Welsh to ask if he had also studied the vasculature coming through the incisive foramen. This was his response:

Although the conventional wisdom regarding anastomosis of posterior septal branches of sphenopalatine artery with anterior terminal branches of the greater palatine artery via incisive canal is repeated throughout the texts and atlases, I was unable to confirm this fact. By sprinting back to the gross anatomy laboratory here upon receipt of your letter, I located the same specimen on which I made the earlier observations. Attention to the incisive canals revealed first that the injected latex dwindled rapidly, requiring the final vascular arborizations to be traced via minute unfilled radicles. The course proved to be as follows:

An anterior extension of posterior septal branches of sphenopalatine artery enters the incisive canal, passes inferiorly into oral alveolar ridge cortex, and terminates in the region of the incisor tooth sockets. Although there were no apparent penetrations from incisive canal into oral mucoperiosteum, there were multiple oral mucoperiosteal vessels perforating the oral cortex of hard palate and alveolar ridge. No contributions from the artery of the incisive canal back into bony secondary hard palate were observed.

Although Welsh was unable to obtain clearance from the Air Force for a complete residency, he did accept a Maytag Fellowship and finally, in 1976, returned to Miami to put the finishing touches on his bony palate vascular research. Welsh, a Harvard Medical School graduate and pithy scholar, has a remarkable depth of knowledge and an uncanny way with words. He admits to having hyperhedonia when digging through the palate bone for shriveled vessels, defining this state as "hi" *par bē dō' ni a, (n)*, abnormal pleasure from doing ho-hum things,” taken from *Mrs. Byrne's Dictionary of Unusual, Obscure and Preposterous Words.*
NERVE SUPPLY

Sensory

The maxillary nerve, the second division of the trigeminal nerve, passes through the sphenopalatine ganglion, picking up the secretory and sympathetic fibers from the facial nerve. This composite nerve then divides into three and is distributed to the nasal cavities, nasopharynx and palate. One of the branches is the sphenopalatine nerve, which passes through the incisive foramen to the anterior hard palate. Then there is the greater palatine nerve, which comes through the posterior palatine foramen, supplying the remainder of the hard palate. The smaller middle and posterior palatine nerves, branches of the pterygopalatine nerve, emerge through the lesser palatine foramen to supply the soft palate and tonsil with sensory branches.

Motor

It has long been known that the motor nerve supply to the tensor veli palatini muscle is different from the other velopharyngeal muscles. W. A. Turner (1889), L. Rethi (1893), L. Druner (1903) and A. R. Rich (1920) all confirmed that the tensor muscle was innervated by the trigeminal nerve, actually the internal pterygoid nerve, a branch of the mandibular, which in turn is a branch of the trigeminal nerve. It is of interest that Harvey Cushing in 1905 reported movement of the tensor palatini by stimulation of the mandibular division of the trigeminal nerve.

There has been and continues to be much disagreement concerning the motor nerve supply to the other velopharyngeal muscles. Most textbooks seem to be satisfied with the general statement that the vagus and accessory nerves supply motor fibers to the muscles of the pharynx and soft palate, with the exception of the tensor palatini, and that the greater superficial petrosal nerve, arising from the facial nerve, also carries motor fibers to the sphenopalatine ganglion and thence to the palatine nerves and soft palate.
E. Cords (1910) and I. W. Broomhead (1951) described these muscles as innervated by branches of the pharyngeal plexus derived from the glossopharyngeal and vagus nerves.

Ivor Broomhead was house surgeon to David Matthews in 1948 and was inspired by him in 1949 to carry out research on the nerve supply of the soft palate in the Anatomy Department at Cambridge University. He later joined Matthews at the Hospital for Sick Children, Great Ormond Street, London, and worked with him until Matthews retired in 1976. In the *British Journal of Plastic Surgery*, 1951, Broomhead reported important anatomical findings for the palate surgeon. He presented a sketch showing the distribution of the glossopharyngeal nerve (IX) and the pharyngeal branch of the vagus (X) to the constrictor muscles of the pharynx, levator palatini, palatoglossus, and the nerve to the medial pterygoid muscle. He also showed the course of the nerves to the palatoglossus and palatopharyngeus on the medial side of the superior constrictor.

A. R. Rich (1920), however, reported levator veli palatini muscle contractions elicited by stimulation of the vagus and accessory nerves, but not by facial and glossopharyngeal stimulation.

The continuing disagreement in the face of many studies of the motor nerve supply to the velopharyngeal muscles intrigued Juntaro Nishio of Japan. He continued his family’s tradition by taking a dental degree, then furthered his studies with a dissertation entitled “The Relationship Between Velopharyngeal Movement and Its Motor Nerves,” for which he earned his Ph.D. In 1976, further excellent work was published in the *Cleft Palate Journal* by Nishio, with T. Matsuya, J. Machida, and T. Miyazaki, of the Oral and Maxillofacial Departments of the Matsumoto Dental College and the Osaka University Dental School of Japan. Their experiments, designed to clarify motor nerve supply to the velopharyngeal muscles, were carried out on 20 rhesus monkeys. (J. F. Bosma and S. G. Fletcher in 1961 stated that basic velopharyngeal anatomy was similar in cats, dogs, monkeys and humans, while C. G. Hartman and W. L. Straus, also in 1961, reported that the course of the cranial nerves in the rhesus
monkey is similar to that in the human being.) Evoked EMG responses of the levator veli palatini, uvula and superior constrictor pharyngeus muscles, which contributed to velopharyngeal closure, were analyzed by the Japanese workers by their stimulating the cranial nerves within the skull. Here is the summary of their results:

1. Muscle action potential (M-waves) from the selected muscles could be recognized on stimulating the facial, glossopharyngeal, and vagus nerves at the petrosal area of the temporal bone but were not noted upon accessory nerve stimulation.

2. At maximal stimulation, the vagus gave a greater increase in muscle amplitude than the other nerves studied. This was followed by the glossopharyngeal with the facial nerve producing the least in amplitude.

3. Also at maximal stimulation, latencies in the response of the levator veli palatini and uvula muscles were reduced to the greatest degree by stimulation of the vagus, to a lesser extent for the glossopharyngeal, and least for the facial nerve.

4. On stimulating the facial nerve below the stylomastoid foramen, M-waves could not be recognized.

From the present study, it was concluded that the levator veli palatini, uvula, and superior constrictor pharyngeus muscles are double innervated by the facial nerve and branches of the pharyngeal plexus derived from the glossopharyngeal and vagus nerves and that the facial nerve plays an important role as one of the motor nerves in the movements responsible for velopharyngeal closure.

They also proposed an interesting theory:

We sometimes encounter cleft palate patients who demonstrate nasal grimace during phonation. This has been considered to be a compensation to velopharyngeal incompetence (Morley). Recently the authors have applied visual training to help cleft palate patients acquire adequate velopharyngeal function. As a result of the training, it was noted that coordinating movements of lip and face, such as nasal grimace or lip-protrusion, during phonation, were useful to activate velopharyngeal movements (Nishio, Yamaoka, Matsuya and Miyazaki). Therefore, the nasal grimace may occur not only to compensate for velopharyngeal incompetence by increasing nasal resistance, but also to fire the facial nerve to complement velopharyngeal movements.
A WARNING

The dissection of fetal and adult heads by Broomhead at the anatomy school at Cambridge has particular significance to palate surgeons, as he concluded his report with this warning:

During operative repair of a third-degree cleft palate damage may be inflicted on the nerve to the tensor palati, resulting in paralysis of this muscle.

Section of the lesser palatine nerves also takes place, and will result in some anaesthesia of the soft palate and paralysis of the musculus uvulae. Whether the mucous glands suffer any damage following the section of these nerves is not known.

The nerves to the palato-glossus, palato-pharyngeus, and levator palati muscles do not, in any part of their course, enter the operative field.
3. Growth in the Normal and the Cleft Palate Patient and the Effect of Surgery on Growth

Lest there be any doubt as to the effect of natural growth, view for a second the comparison that Gillies and I presented in 1957 of a father and son with their noses switched to emphasize the difference. As this is just the nose tip of the iceberg, we must beware that our actions do not interrupt any essential part of the complex facial skeletal process of normal growth.

In 1778 John Hunter proposed that resorption was as determinative of bone growth as apposition. Since bone remains in a continuous state of apposition and resorption along periosteal and endosteal surfaces, the mass and shape of bones are always subject to change.

Donald H. Enlow, then (1971) of the University of Michigan and now of the University of West Virginia, summarized normal growth and development of the craniofacial complex for Cleft Lip and Palate:

Just as the mandible becomes displaced in a forward and downward manner as it actually grows in a predominantly upward and backward direction, several major growth sites in the maxilla similarly grow posteriorly and superiorly but become transposed in an opposite anterior and inferior course.

Enlow used an overlay to show familiar downward and forward manner of facial enlargement, taking the sella as a fixed landmark. The mode of growth shown represents a composite of
actual growth in addition to displacement produced by translocation of the different facial bones away from the cranial base.

An important aspect of maxillary growth—one to be aware of in considering the timing of cleft palate surgery—was established by J. C. Brash in 1924 and T. W. Todd in 1931, when they proved that *five-sixths of the total maxillary width is complete by the end of the fourth year of life*. In 1935 B. H. Broadbent carried out accurate measurements of changes in various components of the face by cephalometric roentgenography. In 1941 A. G. Brodie, using the same method, outlined a complete picture of cranial and facial growth from the third month to the eighth year of life, confirming that the lateral width of the maxilla is accomplished early, but pointing out that downward and forward growth is not complete until the end of the second decade of life.

In 1958 Samuel Pruzansky expressed the situation succinctly in the *American Journal of Orthodontics*:

The skull is a community of bones. Although the several bones may have diverse phylogenetic origins and vary in their individual rates of growth, they are all bound together to give shape, size, and function to the community. When one part suffers in the course of growth and development, it seldom does so in isolation, for the community at large may also reflect, in one way or another, the misfortune of its member.

**THE EFFECT OF CLEFTS ON GROWTH**

As pointed out by David O. Maisels of Liverpool in his Kay-Kilner prize-winning essay in 1966, a complete alveolar cleft will be present by the end of the eighth week of gestation. According to Scott, growth of the interorbital cartilaginous system is responsible for much of the early forward and downward growth of the maxilla. Attached to the septum, the maxillae are carried with it. Latham, Burston and Sarnat have suggested that the potential spaces at the surrounding sutures are "filled in" by bone.

In complete unilateral clefts, the cleft side of the maxilla is separated from the nasal septum, sometimes leaving this lesser segment deprived of some of the usual growth impulses. Thus it may lag in development, be small and retroposed. The premaxilla
on the greater segment tends to spurt forward and rotate to the uncleft side, taking the nasal tip with it, so that the septum is bent and the alar arching over the cleft is flattened. In complete bilateral clefts, the unrestrained growth of the septum projects the premaxilla forward like a figurehead on a ship’s prow, leaving the disappointed lateral segments behind. In both unilateral and bilateral clefts there may be some slight collapse of the lateral segments at birth, which appears to increase during the next few months, even in the absence of surgery. In 1960 and 1965 orthodontist W. R. Burston of Liverpool claimed this to be more apparent than real because of differential growth rates between the maxilla and mandible. A varying degree of retrognathia is usually present at birth, and, as the mandible catches up and grows forward, it may outgrow the maxilla and give the false impression of increasing maxillary collapse.

As septal growth is maximal during the last six weeks of gestation, premature babies usually show less marked deformities than those that go to full term. After a short neonatal pause, there is another growth spurt for about six months, which accounts for the increasing deformity taking place in untreated babies before our eyes. Thereafter a fairly stable condition is reached in the upper dental arch with only minor changes in the maxillomandibular relationship.

THE EFFECT OF SPECIFIC TRAUMA ON GROWTH

Bernard G. Sarnat of Cedars-Sinai Medical Center, University of California, Los Angeles, was head of oral and maxillofacial surgery at the University of Illinois for many years. He worked with William Logan while a resident at Cook County Hospital, Chicago, and was first assistant to Vilray Blair for three years in St. Louis. He watched Blair consider Brophy’s work and eventually become disenchanted because of the poor results. This early clinical experience no doubt stimulated him to study bone growth, and his findings are important. In 1969, in Alpha Omegan, he wrote:
Primary Growth Centers

Primary endochondral centers ... in the skull are the sphenethmoidal and sphen-o-occipital synchondroses, and the septoethmoidal and septo-presphenoid joints, and the mandibular condyle. These centers contribute to the downward and forward growth of the face. . . . The loss of anatomical continuity with changes in muscle balance must also be considered as a contributory factor. The truth of this fact was demonstrated by the severe deformity of the jaws and face that resulted after extirpation of the mandibular condyle in growing monkeys.

Secondary Growth Sites

Growth of bones is also active at secondary or accommodating growth sites. Appositional growth, as well as modeling resorption, occurs on the surfaces of bones (periosteal and endosteal) and contributes to growth in all directions. Sutural growth is only in the skull.

It was demonstrated in growing rabbits that considerable growth of bones occurred at the frontonasal suture. The nasal side contributed approximately twice the amount that the frontal side contributed. Extirpation of this suture, however, did not affect grossly the growth of the snout. Similarly in growing monkeys, extirpation of the midpalatine and transpalatine sutures resulted in no gross alterations in either facial or jaw growth.

Growth of the cartilaginous nasal septum contributes to the downward and forward growth of the face and palate and thereby influences sutural growth. The contents of certain other cavities of the skull likewise influence the growth of a complex of adjoining bones and sutures. Examples are the brain and the neurocranium, the orbit and the orbital contents, the tongue and the oral cavity. Muscle activity, both local and regional, also plays an important role.

At the International Congress of Plastic and Reconstructive Surgery in Rome, 1967, Sarnat summarized the differential effects of surgical trauma to the nasal bones and septum upon rabbit snout growth:

Although it was found that the frontonasal suture was a site of active growth, extirpation of it did not affect grossly growth of the snout. Dislocation of the cartilaginous nasal septum likewise did not affect grossly growth of the snout. In contrast however, resection of cartilaginous nasal septum produced a severe and striking growth arrest of the snout.

He presented lateral, frontal and dorsal views of rabbit #4, in which a minor amount of the nasal septum was removed, dem-
onstrating a relatively normal, long, tapered face. Similar views of rabbit # 18, in which a major amount of nasal septum was removed at 21 days of age, reveals a short, stubby, rounded face with an indentation above the nostrils and an over-erupted lower incisor (from B. G. Sarnat and M. R. Wexler, *Amer. J. Anat.*, 118:755-767, 1966).

Sarnat stated in summary:

From these experiments it is concluded that the frontonasal suture is a secondary or accommodating site of growth whereas the cartilaginous nasal septum is a primary site of growth.

Here are Sarnat's 1969 thoughts on clinical application of his research:

In a child with a complete bilateral cleft palate, the upper jaw may be unable to obtain a full expression of downward and forward growth because of lack of contact of the palatal shelves with the ventral-free actively growing septovomeral region. Furthermore, trauma to the septal region, during cleft palate or septal surgery, might have an untoward effect upon growth of the nose, upper jaw, and face. Injury to the midpalatine or transpalatine sutures, which are secondary growth sites, is of less import. . . .

Functional and cosmetic treatment of growth deficiencies of the face is more difficult than treatment of growth excesses. . . . Even though the deformity may not be progressive, it is not self-correcting and there is no way to compensate for lost or retarded growth. Orthodontic, prosthetic and surgical procedures offer functional and cosmetic improvement. The operations commonly used are directed toward altering malposition and contributing bulk. Osteotomy with or without a bone graft and cartilage, bone, or alloplastic materials, as a masking procedure has been utilized. Certain aspects of treatment may be undertaken when the patient is still growing, but the final result cannot be attained until growth of the face has ceased.

**OTHER PERTINENT ANIMAL STUDIES**

As early as 1958, Sarnat reported no growth arrest in the palate or face of young monkeys that had unilateral removal of palatal mucoperiosteum or palatal mucoperiosteum and bone. Yet Herfert's work directly contradicted Sarnat's research.

Wolfgang Rosenthal founded a maxillofacial surgery hospital in a charming old castle at the village of Thallwitz near Leipzig, Germany. Here 130 primary cleft lip, 150 primary cleft palate and
350 secondary operations were carried out annually. Oskar Herfert, with both dental and medical degrees, joined Rosenthal and was stimulated by him to examine 350 postoperative cleft lip and palate cases. He discovered that patients in whom the palate was operated on between 2 and 5 years of age showed restriction of growth of the upper jaw. Sixteen had a lip closure but no palate operation until 12 years of age, and their upper jaw deformities were minimal. This finding confirmed what Rosenthal had already stated in 1927:

Operations on cleft palates of children from 2 to 4 years of age retard to a greater or lesser extent the subsequent development of the upper jaw. If such operations ... are withheld until the child is 12 years of age, the upper jaw can develop normally and intermaxillary occlusion is more satisfactory.

Herfert was now prompted to experiment on a litter of terrier puppies. He published the results in 1954 and then again in the British Journal of Plastic Surgery in 1958. His experiment utilized an incision on the right side of the palate from the canine incisor to the second molar tooth, the raising of a mucoperiosteal flap from the bone, excision of a small strip of this flap and division of the posterior palatine artery. The narrowing of the palate on the operated side averaged 19 percent. A second series was done lifting the mucoperiosteum but not ligating the posterior palatine artery. Herfert concluded:

It can surely be stated that limitation of growth does in all cases appear to have taken place but to a greater extent in those cases in which the palatine artery was ligatured.

Herfert was director of maxillofacial surgery at Rostock on the Baltic Sea in East Germany until 1960, when for political reasons he was forced to become a refugee to West Germany and had to start all over again, eventually becoming a professor at Johannes Gutenberg University. His important early findings in dogs gave fuel to the orthodontists and even concern to some surgeons.

By 1967, confirming data had been reported by Charles R. Kremenak of the University of Iowa, who showed in puppies that the unilateral excision of a 4 mm. wide strip of mucoperiosteum just medial to the posterior teeth caused a definite decrease in palatal width (27 percent narrower on that side). Mere elevation
of a unilateral mucoperiosteal flap or ligation of the palatine artery each caused only a 3 percent narrowing of the palate. This information was sufficient to cause some surgeons to make their lateral relaxing incisions in the mucoperiosteum more medially and farther away from the teeth.

In 1977 in Toronto Kremenak noted:

We learned, after Herfert, that surgery leaving bare bone next to teeth hindered jaw growth but did not understand why. Earlier reports byBillingham, Grillo and Gross and others supplied a clue: data on contraction in healing of full thickness skin wounds resembled data on postsurgical jaw growth in our animals. Could contraction in early healing be the reason for surgical interference with jaw growth? The answer in our animals was at least a partial "yes." Could the contraction phase of healing be prevented? . . . Majno's group reported observations of newly recognized myofibroblasts in granulation tissue; their work and that of Wessel's group suggested that in vivo pharmacologic regulation of contraction might be possible. Madden et al (1974) reported an animal trial; we began similar work.

Kremenak reported that immediate split-skin grafts to the denuded bone prevented much of the usual growth lag.

Yet it is somewhat difficult to evaluate dog palate experiments in relation to man. Scholarly M. J. Jurkiewicz of Emory University is one of the Pied Pipers of plastic surgery in academic medicine, drawing outstanding students into our specialty with his exciting teaching of fundamentals. While at the University of Florida, he had a mixed colony of cleft lip and palate dogs which were being used in an experiment in genetics. As he explained to me in 1972 and 1976, during operations on canine clefts—both isolated cleft palate and cleft lip and palate—he found extending forward from the greater palatine foramen the descending palatine vessels, which freely anastomosed with the anterior branches of the descending palatine vessels emerging from the incisive foramen, much as in the human. He noted important differences:

The incisive foramen in the dog is approximately three times the diameter of the greater palatine foramen. All along the canal accommodating the vessels are a number of tiny foramina which admit tiny nutrient vessels to the palate which appear to come from the bone the whole length of the palate. Basically, therefore, my impression is that there are many more lesser
palatine vessels than there are in the human, and the anterior descending palatine vessels, which emerge through the incisive canal, carry a much greater volume of blood than do the posterior vessels. I can say from experience that the standard von Langenbeck repair in complete clefts in the dog is fraught with complications in healing, often resulting in slough of the anterior portion of the flaps. I think this is because we did not pay enough attention to the contributions from the anterior vessels emerging from the incisive foramen. . . . Thus I would tend to agree with you that it would be difficult to transpose dog experiments into the human condition.

Similar difficulties have been encountered in the cleft palate of the horse.

STUDY OF THE EFFECTS OF SURGERY ON HUMAN GROWTH

For centuries surgeons obsessed with closing the hole resorted to drastic surgery on the lip and palate, eventually causing dentists faced with unbelievable dental distortion to start an anti-surgery war cry.

J. Daniel Subtelny, orthodontist and researcher in Rochester, New York, has been a leader in the attempt to get to the truth. His original work with frontal plane tomography (Subtelny, 1957; Coupe and Subtelny, 1960) added insight into the anatomy of the cleft palate beyond that presented by plaster casts. In 1962 in Plastic and Reconstructive Surgery he gave an excellent review of cleft palate studies during the previous 10 years. He first cited two monumental landmarks in the chronology of cleft palate growth studies, one by T. M. Graber in 1949, cross-sectional in nature and dealing with the past, and the other by S. Pruzansky in 1957, which was longitudinal in design and dealt with the future.

VOTES AGAINST EARLY SURGERY

Graber was one of the first to study a large number of postoperative cleft palate individuals using cephalometric x-rays to evaluate objectively the skeletal structures of the faces of the postoperative group for comparison with those of non-cleft individuals. He came to the startling conclusion that the maxillary jaw in post-
operative cleft palate cases is deficient in all dimensions—that is, in vertical and lateral, as well as anteroposterior, dimensions. The most marked reductions in the size of the maxilla were apparent where an early surgical closure of the cleft palate or a great number of surgical procedures had been performed. His findings seemed to suggest that surgical injury to growth centers of the maxilla and palatine bones was responsible for skeletal deformities. M. W. Buck of the University of Iowa confirmed Graber’s maxillary findings in 1951 and agreed with Graber that the mandible also was smaller than in normal patients. In 1954 Snodgrass found retardation in growth, but more in the maxilla than the mandible. By 1954 Graber had reported on a larger cleft palate sample of 250 patients and strongly stressed that facial growth in unoperated cleft palate patients closely approximated that in the normal. In his view there was no real deficiency of tissue in cleft palate infants, and if no surgery was performed, they would show little or no growth disturbance. Graber took the stand that surgical closure of cleft palate should be postponed until 5 years of age, emphasizing that the maxillary dental arch had been found to be more normal in patients whose palates had been closed after 4 years. In 1954 W. Krogman advocated postponement of palate surgery to 4 to 6 years of age, justifying the delay with the fact that the major portion of maxillary width growth has been attained by 5 to 6 years of age.

Impressed with Graber’s early awareness and intrigued to know more, I wrote him in 1976 at the University of Chicago and was highly rewarded. Thomas M. Graber has four sons who are eagle scouts, and if he had done nothing else in life, he would deserve a whole sash of merit badges! Yet he has been a pioneer in the cleft field and his reminiscences are both fascinating and provocative:

I attended Washington University Dental School from 1936 to 1940 where the dental and medical schools are contiguous and there was a fair degree of interchange. Dr. Jorstad, our pathology teacher, pointed out we had one of the world’s best surgeons on our staff—Dr. Vilray Papin Blair. Almost of the same stature was Dr. James Barrett Brown. I was lucky enough to be admitted to the amphitheatre a number of times when they were operating. Dr. Blair was a great showman and made his operations “live.” Barrett,
more taciturn, was a master craftsman, and I was much impressed by the
ability of these men to work in such a small field, with so many tissues, and
achieve an apparent success. Naturally, I read all they had written and got
hold of Dorrance's text. The controversy in the field of cleft palate rehabili-
tation became apparent. I did a survey article, "Cleft Palate and Hare-lip,"
for the Washington University Dental Journal right before I graduated, and it
was apparent by then that immediate surgical success did not mean that
everything was normal forevermore. Seeing a number of cleft patients in the
dental clinic with tight lips, mid-face deficiencies, poor speech, high caries
incidence, deformed maxillary arches and psychological problems after the
holes had been closed in the face and the mouth made me wonder what was
happening in the growing face, since these problems seemed to get worse as
the child matured.

In World War II, I saw a number of severe facial injuries and found them
depressing. . . . But the cleft children seemed different. They looked so
normal after Drs. Blair, Brown and Byars were finished and seemed to grow
into a deformity. I wondered if there was some possible way we dentists
could guide such growth and prevent the developing facial deformities?
With this in mind, I entered a graduate program in orthodontics at
Northwestern University and later joined the staff at Children's Memorial
Hospital in Chicago. Dr. Louis Schultz was doing the cleft palate surgery
according to the approach of Truman Brophy. You know the results as well
as I—really depressing. Fred Merrifield, head of Oral Surgery at Northwestern,
shared my concern. We were aware of the work of Wayne Slaughter and
I had a chance to visit with him, to see his patients and to know of his
concern over early traumatic surgery. Finally, Merrifield got a grant and we
set up the Northwestern University Cleft Lip and Palate Institute in 1947. It
was then I began my growth research and had ample cleft material both at
CMH and Northwestern. Most of it was patients treated by the Brophy
technique. The Blair-Brown-Byars cases had never looked that bad. Why the
difference? How to prevent or correct the surgical results? I recall one case
vividly. The patient was the young wife of a dentist who came to our clinic
about 1952. The maxillary arch was collapsed, totally contained within the
mandibular arch, and the usual midface concavity and short, tight upper lip
were present. We had already spread the maxillary buccal segments in a 14
year old girl earlier in the year when the palate repair had broken down and
obtained two centimeters of basal bone repositioning, in addition to moving
some teeth. With a tight, unyielding and scarified palate, I saw no way of
doing the same for her and timidly suggested we cut the repaired palate to
enable the spread. Tears came to her eyes and she exclaimed, "You mean you
actually want to open the cleft, after I have gone through so many opera-
tions to close it?" It was totally incomprehensible for her to understand our
concern over jaw growth, jaw size, jaw position. The be-all and end-all for
her . . . and for so many surgeons and patients was the mechanical closure of the hole. Never mind the function, the resultant deformity and growth arrests of contiguous structures—close the hole at all costs!

With new surgical techniques, with grafting, with orthopedic procedures, things have improved. But I still see the need for better dissections of muscles, for means of relieving lip tension on the sensitive and responsive maxillary bone and teeth. Perhaps we may be able to help with some sort of plastic splints that fit in the oral vestibule and prevent lip contact with the alveolar bone and teeth—that actually stretch the soft tissue. This could be one advance for the future.

In 1954, in the British Journal of Plastic Surgery, A. Jolleys reported on a study of 254 children with cleft palate treated by a variety of surgical procedures at different ages. He observed a reduction in maxillary development regardless of operation or time of surgery and blamed this retardation on fibrosis. It is interesting that speech was found to be worse in the patients who had undergone surgery after 3 years of age. This finding led Jolleys to suggest that the simplest surgical procedures be used, the soft palate be closed as early as possible, leaving the hard palate till the eighteenth month of age.

At the Hamburg Congress in 1964, Longacre noted that the difference in final results depended on the time of the palatal surgery:

It is a well-known fact that the premaxilla unites with the maxilla to establish the maxillary arch between the age of four and five years. As I mentioned, we have run two parallel series using exactly the same technique. (1) An early age group before two years of age, and (2) a group at the age of four. As we have carefully analyzed these, we have noted a degree of cross-bite due to collapse of the maxillary segments in the younger group; the degree of cross-bite in the older group is definitely less. Also the degree of deformation of the anterior face and the degree of contraction of the maxilla in all three directions is definitely less.

A SEARCH FOR UNOPERATED ADULT CLEFTS

A possible control population with a potential for throwing some light on the effects of palate surgery on facial growth was, of course, unoperated cleft palate adults. Both surgeons and dentists
began scrambling around in search of these cases to help settle the argument of *just when the patient is really ready for surgery*. Yet finding unoperated adult cases was not so easy in the more advanced areas of the world for, as Claire Straith said over 25 years ago,

If I don’t operate early on this cleft baby, someone else will!

The courtly Fernando Ortiz-Monasterio, a pre-Columbian history scholar at General Hospital, Mexico City, is a skilled sailboat racer who represented Mexico in the Tokyo Olympics. In 1959, with Rebeil, Valderrama and Cruz, he reported cephalometric measurements on unoperated cleft palate adults in Mexico revealing that growth had not increased the deformity. From 1963 to 1972 Monasterio has had an unsurpassed experience of 450 late unoperated clefts, 250 of the patients being over 15 years of age. At the Cleft Palate Congress in Copenhagen in 1973 he reported the occlusion in both the unilateral and bilateral clefts to be normal, except in the area of the actual cleft. Also in 1973, he wrote:

We started 19 years ago with a very modest cleft palate clinic which has grown both in number and maturity of the members of the staff and patients. It is very large nowadays. Faced with a large number of unoperated adults we became aware (and corroborated by our cephalometric studies) that early or aggressive surgery was the main factor in growth deficiency and/or collapse of maxillary segments.

Further information on unoperated adult cleft palates was provided by the orthodontic team of J. Mestre, J. De Jesus, and J. D. Subtelny of Rochester, New York, in 1960. This is their succinct summary:

Cephalometric X-rays of forty-nine adults with unoperated clefts of the palate were compared with cephalometric records of thirty noncleft adults. The subjects ranged from fifteen to fifty-seven years of age and were located on the island of Puerto Rico. . . . The study showed that the mature skeletal relationships of the jaws did not differ significantly in the unoperated cleft palate adults when compared with the normal adults. Particularly, the dimensions of the maxilla and the positions of the maxilla within the craniofacial complex were found to be normal in the cleft palate subjects.
In 1967 Ivo Pitanguy of Rio, with T. Franco, went one step further to claim that unoperated palate clefts in his series of 84 improved with aging.

These findings of improvement in time were also observed by C. O. Innis in unoperated adult clefts of the Dusan tribes of North Borneo. He concluded that most deformities seen in the Western world in postoperative cleft patients were iatrogenic. I had noticed effects in adult unoperated clefts in Korea and Jamaica. At the Cleft Palate Congress in Copenhagen in 1973, R. J. Maneksha of Calcutta confirmed similar findings in his unoperated adult cleft Indian population. In 1974 Ralph Blocksma recalled:

The consistent excellence in facial development of individuals with unoperated clefts which [I] observed in Pakistan 30 years ago . . . [confirmed] the basic truth that oral-facial development in unoperated oral cleft individuals proceeds generally in a normal way.

In 1972 Frank McDowell threw us a provocative curve by adding another dimension:

Having observed a considerable number of patients with wide single clefts and total double clefts who have grown up without surgery of any kind, I saw all sorts of distortions which came late in the growth of these unoperated patients. I am sure that the problem of lip repair is not alone the simple mechanical immediate restoration of contour in the very young infant, but we have to deal with all the distortions that would have developed anyway if the patient had never been operated on, plus the influences exerted on these distortions by every scar produced in the lip, nose, cheek or palate. If all these factors were ever programmed on a computer, and someone pushed the answer button, it would probably blow all the fuses.

In a slightly less dramatic presentation, the maxillary distortions of the unoperated cleft were confirmed in 1977 in Toronto by S. Bishara, W. Olin and C. Krause of the University of Iowa, when they clinically and cephalometrically compared dentofacial relations of 8 unoperated clefts of the lip and alveolus, 12 unoperated clefts of the lip and palate and 20 normal individuals matched for age, sex and ethnic background. Their findings suggested that different cleft types have different clinical, dental and cephalometric characteristics. They reported:
Some of the significant findings include a relative maxillary skeletal protrusion in the lip/alveolus group while the lip/palate group indicated a relatively steep mandibular plane and more upright lower incisors.

**INDIVIDUAL VARIATION**

As condemnation of early surgery was gaining momentum, another controversial figure, in the form of Samuel Pruzansky, loomed on the scene. At first he appeared arrogant, impudent, and as irritating as a picador. Yet as the inflammation settled, it became evident that his confidence came from having done his “homework” and his sharp tongue was not attacking any specific group; he was only in search of the truth. As he said:

My early reading was from Fogh-Andersen and Victor Veau; their writings and conceptual approach affected me most of all.

So when others were condemning all palatal surgery, Pruzansky, from his longitudinal studies, presented conflicting opinions. As he explained:

When the longitudinal growth study of children with cleft lip and palate was initiated at the University of Illinois in 1949, it was our expectation that the collection of casts, cephalometric radiographs, photos, family and medical history, and other related data would describe and measure the *initial state* of the unoperated infant, document the *manoeuvre* in the form of surgical or other treatment, and the *subsequent state* through long term follow-up.

Whereas maxillary deficiency was being found in some post-operative cleft palate patients, there were others who were growing normally. As Pruzansky pointed out in 1954,

The child with a cleft palate is first of all a child. As such, he is endowed with inherent potentialities for growth and development that reflect his genetic heritage and the metabolic climate in which he thrives.

In other words, some cleft palate patients have a potential for attaining a favorable facial appearance while others, from birth, do not. In fact, in 1954 W. B. Slaughter, plastic surgeon, and S. Pruzansky noted that surgery could actually aid and direct natural development processes through the reestablishment of more normal muscle forces. This finding caused greater attention to be
directed toward the actual surgery. Many of the cases which had caused so much concern over maxillary growth deficiency had been submitted to Brophy’s surgical maneuvers, using constricting wires to reduce a cleft mechanically by forcing the bony segments of the maxillary jaw together!

Egil Harvold of the University of Oslo and the Norwegian Dental School also resisted the stand that palatal surgery before 5 years of age inevitably leads to facial disfigurement. In the 67 postoperative cleft palate patients he studied in 1954, the deformities were not necessarily the results of reduced growth potentials. The change in the position of the separated maxillary jaw parts, he noted, can cause maxillary constriction, and deformities in the nasal septum and premaxilla are evident in fetal life. Harvold did admit:

It cannot be denied that the greatest deformities in the lateral segments of the alveolar process arise where surgical treatment has left abundant scar tissue, while the symmetry aberrations and the deformities are relatively limited where the palate has not been operated upon. It is also apparent that orthopaedic treatment may result in almost normal development in this area when it aims to eliminate the unfortunate influence of scar tissue formation in the palate and attempts to establish the most nearly normal eruptive conditions for the permanent teeth in the lateral segments.

In 1973 prosthodontist T. Ramstad of the University of Oslo, Norway, noted:

Loennecken’s introduction of improved surgery [trained by Gillies] represented a milestone in cleft palate treatment in the Oslo area, and his conservative procedure led to a marked improvement in maxillary development.

In 1956 L. T. Swanson, D. W. MacCollum and S. O. Richardson studied more than 100 children with clefts of the palate surgically closed prior to 2 years of age. The skeletal profile of the face was compared to an “ideal” concept and an average profile attained from a random sample. The cleft children did not conform to the “ideal” but were closely related to the normals selected at random. These palates had been closed gently by the MacCollum-type Langenbeck and were considered good results, not justifying delay of surgery to 4 to 7 years of age.
In 1958, in the *American Journal of Surgery*, Richard Webster, Lawrence Quigley, Richard Coffey, Robert Querze and James Russell of Brookline, Massachusetts, proposed pharyngeal staphylorrhaphy and speech aid as a means of avoiding maxillofacial growth abnormalities in patients with cleft palate and concluded:

We plan to delay surgical closure of the hard palate clefts until the child is between the ages of five and eight, or even longer, unless complications unknown to us at present arise.

Pruzansky has demonstrated differences in growth changes in many cleft palate patients even prior to palatal surgery; some clefts narrow with age and others do not. This may be especially the case after lip cleft closure but the same discrepancy has been observed in posterior clefts with no involvement of the lip or alveolus. The palatal shelves may be growing more in some clefts than in others. From serially accumulated plaster cast reproductions of the face and jaws of newborn infants with cleft lip and palate, Pruzansky deduced:

Cleft lip and palate do not represent a single fixed clinical entity subject to generalizations of description and classification and, least of all, rigid therapeutic formulae.

These factors he does consider important:

1. Extensiveness and width of the cleft.
2. Adequacy of parts and amount of deficiency.
3. Evaluation of cleft segment misplacement and/or distortion.

In 1960 T. B. Coupe and J. D. Subtelny studied 127 cleft palate children under 3 years of age with cephalometric lamino-ography and found:

There was a definite tendency toward a deficiency of hard palate tissue in all types of clefts of the palate. Of course, individual variation was noted. . . . The bilateral cleft palate subjects tended to show the greatest amount of tissue deficiency . . . the greatest amount of displacement of the maxillary bones. . . . The posterior cleft palate cases were observed to have a greater degree of tissue deficiency than the unilateral cleft cases, while the unilateral
cleft cases showed a slightly greater amount of tissue displacement than the posterior cleft cases. Therefore, one of the very basic differences between cleft palate and non-cleft palate subjects is to be found in the quantity and spatial position of hard palate tissue.

Morphological differences in other skeletal areas have also been found. In 1956 M. L. Moss noted possible malformations of the base of the cranium in the cleft palate individuals, and in 1954 R. M. Ricketts noted that cleft palate cases may show some deviation in the base of the skull. In 1955 Subtelny, for example, observed that the hamular processes of the medial pterygoid plates of the sphenoid bone are farther apart in unoperated cleft palate children than in non-cleft children, indicating an abnormally wide nasopharynx in cleft palate cases. G. H. Borden of the University of Illinois studied mandibular growth in cleft palate subjects and in 1953 noted that the rate of growth in the cleft palate group was slightly below that in the non-cleft group. Pruzansky emphasized the importance of mandibular growth in bilateral clefts of the palate. Following surgical resection of a part of the vomer and premaxillary setback, it was often observed that the premaxilla did not follow the downward and forward growth of the maxilla, and gross facial disfigurement ensued. Yet in many patients with a projecting premaxilla facial appearance improved with growth after surgical resection of a portion of the vomer. It was demonstrated that the downward and forward growth of the mandible, as well as the maxilla, permitted these structures to catch up with the premaxilla, which seemed to be held in place by the tension of the closed lip. In some children this improvement in facial appearance occurred quickly, with rapid growth of jaw structures; in others growth and facial improvement progressed more slowly.

At this time in the evolution of palate surgery, the death knell had been sounded for early traumatic surgical methods, while sound, gentle procedures promised to correct anatomy, improve physiology and, in fact, encourage and direct growth.

In 1972 Toshiki Minaba of the Tokyo Dental College summarized his growth studies using lateral roentgenographic cephalograms of 291 cleft lip and palate patients and 160 normals,
concluding that facial growth is retarded in all cleft groups. He noted several points specifically. The forward growth of the lower part of the orbits in cleft lip and palate and cleft palate groups is inferior to that of the normal. Forward and downward growth of the maxilla in all cleft groups is inferior to that in the normal but is more inferior in the cleft lip and palate group than in the cleft palate group. Minaba also recorded that downward growth of the posterior part of the mandible in both cleft lip and palate and cleft palate groups is slightly less than in the normal. The mandibular plane angle, gonial angle and ramus angle are larger in cleft lip and palate and cleft palate groups than in the normal, but the mental angle is smaller, and all become more remarkable with advancing age. Finally, labial inclination of the upper incisors and lingual inclination of the lower incisors is greater in cleft lip and palate and cleft palate groups than in the normal.

His conclusion:

It seems that repairs of both cleft lip and palate affect the growth of the maxilla. Consequently, tight lip must not be reconstructed in cleft lip repair; and also techniques involving comparatively little surgical invasion ought to be adapted to cleft palate repair.

Kenneth L. Pickrell, with E. Clifford, G. Quinn and R. Massengill, reported in 1972 on 100 cleft lip and palate patients operated on by him 22 to 27 years previously, using the Wardill palatoplasty at about 18 months:

There was maxillary collapse in all instances in which the cleft involved the alveolus and the maxilla.

In 1972 Crikelair, Price and Cosman divided maxillary deformities in postoperative cleft lip and palate patients into four main categories:

1. Medial collapse of the cleft segment of the alveolus with eventual crossbite.
2. Anterior-posterior shortening of the maxilla with its retrognathism.
3. Decrease in inferior-superior height of the maxilla on the cleft side with tilting up of the cleft segment off the plane of occlusion.
4. Buckling inward, or hourglass deformity, of the lateral portions of the alveolar arch.

**HOURGLASS MAXILLARY COLLAPSE**

The "buckling collapse" deformity was first noted by T. D. Foster of Stoke Mandeville, England, in 1962. It appeared postoperatively in 11 of 102 complete unilateral cleft lip and palate cases, 4 of 47 bilateral complete clefts, and 7 of 19 postalveolar cleft palates without cleft lip. Foster made another important observation: In the unilateral cleft lip and palate case the buckling was bilateral and essentially equal on both the cleft and non-cleft segment. In 1972 Crikelair, Price and Cosman presented two examples of this deformity which had occurred among the postalveolar clefts operated on at Columbia Presbyterian Hospital between 1958 and 1968. They entitled the deformity "hourglass maxillary collapse." One case was a standard postalveolar cleft treated by the routine von Langenbeck procedure which was followed with uneventful healing. At the age of 10 years, the child presented an hourglass collapse without anterior-posterior shortening. In the second case the operation was done at 4 years with a pushback procedure to close the anterior portion of a wide, horseshoe-shaped postalveolar cleft. At age 6 a von Langenbeck procedure closed the posterior portion of the cleft. Turnover flaps were used to close fistulae at ages 8 and 9. At age 21, dental models presented the hourglass maxillary collapse. Crikelair, Price and Cosman made pertinent comments about this deformity:

It is the only form of alveolar arch deformity found in the alveolar cleft palate patient. The defect is clearly related to surgery. The mechanism of its cause is uncertain, but may be a denuding injury to the palatal bone shelf immediately adjacent to the tooth line rather than operative site scar contracture. Elimination of releasing incisions or their placement further away from the alveolar ridge is suggested as a potential means of preventing this form of maxillary collapse.

It would seem likely that at least isolated palatal clefts with the anterior strut of an intact dental arch would not be affected by early elevation of mucoperiosteal flaps. Yet R. Hellquist, B.
Pontén and T. Skoog reported in 1978 on 99 isolated clefts operated by a V-Y or Dorrance-type pushback procedure at the age of 18-24 months. At the age of five years the frequency of anterior crossbite was 38 percent in patients with large palatal clefts, compared with 19-21 percent in patients with smaller clefts. In boys with cleft palates the frequency of anterior crossbite was 13 percent higher than in girls, in spite of the fact that the incidence of large palatal clefts was lower in boys. In cases of large clefts of the secondary palate, the incidence of anterior crossbite was 12.5 times higher than in noncleft patients of the same age.

In 1973 at the European Orthodontic Society meeting S. Pruzansky, with H. Aduss, S. Berkowitz, H. Friede and K. Ohyama, summarized the progress of their longitudinal growth studies. Their 4,000-case survey has provided a view of the wide spectrum of variation encountered in each cleft type in the unoperated state and the changes due to growth or specific therapeutic maneuvers. They noted:

As our observations expanded, it appeared that, within certain defined limits, the success or failure of the surgical procedure depended more on the initial state than on the variables inherent within the maneuver. . . . In studying the effect of lip repair on the facial profile in complete bilateral cleft lip and palate, Friede and Pruzansky (1972) found that the following two factors characterizing the patient were more predictive of the ultimate result than who did the surgery:

1) The amount the premaxilla projected in the initial state was found to vary by a multiple of two. Thus, the patient whose premaxilla projected the least in the unoperated state presented the better profile at the earliest age, while those which projected most exhibited the poorest results, irrespective of who did the surgery.

2) The pattern of mandibular growth was a significant independent variable in determining the ultimate cosmetic improvement in the facial profile. A prognathic mandible could mask the characteristic midface convexity, while a retrognathic lower jaw would only accentuate the premaxillary protrusion. . . . Given two surgeons of similar competence and utilizing procedures that did not vary greatly in principle, the ultimate success or failure was less dependent on differences between them than on the variables within the patient.

In their study of the initial state, it was apparent that clefts cannot be lumped together, as noted in 1972 by A. Burdi, M.
Feingold, K. S. Larsson, I. Leek, E. F. Zimmerman and F. C. Fraser. Long conscious of this principle, Sam Pruzansky, in 1953, as the first published sentence to emerge from his research, stated:

Not all congenital clefts of the lip and palate are alike.

When asked by a National Institutes of Health site visitor what he considered his most important contribution to the cleft palate literature, he responded that he had never been able to exceed the profundity of his first sentence. Of course, he elaborated on the unpredictability of clefts when he stated in 1958:

Recognizing that certain congenital deformities will show spontaneous improvement in time, while others will remain the same and some will grow worse, is of practical value.

And later,

The same funny-looking kid looks funny for different reasons at different times.

Pruzansky is concerned with the many factors that are involved. Is there an adequacy of parts, the cleft being merely a non-union of normal parts, or is there an intrinsic inadequacy? How much distortion is present? Then there is the geometric relationship of contiguous anatomical structures. The status of the mandible, posture of the tongue, anomalies of the skull base and upper cervical column and of the anatomy of the nasal cavity—all have their influence on the final result.

These longitudinal studies have provided crucial information on craniofacial growth in children with clefts and have demonstrated that current surgical practice which does not resort to presurgical maxillary orthopedics and primary bone grafting can produce satisfactory results without interfering with growth (Aduss, 1971), contrary to reports in the 1940's of the deleterious effects of surgery on the growth of the mid-face.

Their analysis of the initial state suggested that under certain conditions surgical repair of the palate is feasible quite early, while in other instances, optimal conditions for repair will not become evident until a later age. In our experience a selected number of cases underwent palatal repair at or before one year of age without detriment to
midface growth. . . Age at surgery is not a primary variable in determining the effect on facial growth. Quantitative and qualitative characteristics of the defect, general health and genotype of the individual are determining factors.

Pruzansky concluded with this statement, having already made it clear that he stood strongly in camp 2:

It would seem that we [the cleft palate workers] are still divided into two camps: (1) Those who believe that cheiloplasty should be supported by pre- and post-surgical maxillary orthopedics with or without primary bone grafting; (2) those who hold that the effectiveness and benefits of such procedures are limited and the costs incurred are inordinately high for the value gained.

In 1975 S. Pruzansky and Hans Friede came upon some evidence to help confirm their general position. Two sisters, daughters of migrant workers, were reported with unoperated bilateral cleft lip and palate. They were 5 years 8 months, and 3 years 11 months of age and both revealed a degree of premaxillary protrusion similar to that in unoperated infants.

Pruzansky noted on the other hand,

Children operated in infancy showed less midfacial protrusion than the sisters following repair of their lips at a later age suggesting that the repaired lip has a long-acting effect in restricting growth of the premaxillary-vomerine complex. Later, forward growth of the mandible and elongation of the face also serve to minimise the convexity due to the projecting premaxilla.

About a year ago I asked Sam Pruzansky for an up-to-date summary of his feelings on cleft palate. After scanning Volume I of Cleft Craft, he hastened to respond in a manner that well portrays the man and his stand:

Cleft Craft is a scholarly tome and also a happy by-product of the increasing communication between scientists and clinicians throughout the world that is dissolving the provincialism that prevailed when I first became interested in clefts in 1949.

Over the years, I developed a central hypothesis that unifies much of our research. It is at the opposite pole to your own thinking which quite properly emphasizes the craft, even though you recognize that the final result “must depend upon the sculptor and his clay.” My mission is to analyze the clay.
As Feinstein stated, there are 3 elements in the architecture of clinical research design:


I know of no satisfactory way to control and document the manoeuvre. Therefore, there evolved the hypothesis that the initial state (the clay) is the precondition that determines the subsequent state, given a cadre of plastic surgeons of nearly equivalent competence and utilizing similar principles.

Toward that end, a combined prospective and retrospective study has been undertaken to analyze the complete unilateral cleft lip and palate, paying attention to some of the variables that Pfeiffer first discussed.

As you noted on pp. 20–23 of *Cleft Craft*, there are a number of variables, inconstant in their severity, that characterize the complete unilateral cleft lip nose. Some of these variables I have measured and reported in collaboration with H. Aduss. I should like to elaborate on your list and add some additional variables:

2. The turbinates on the cleft side vary in size, shape and position and have an influence on subsequent arch form in the complete unilateral cleft lip and palate.
3. The nasal floor is affected by the variable inclination of the palatal shelves. The palatal shelf on the cleft side may be superior, at the same level, or inferior to the non-cleft shelf.
4. The philtrum is variable and in a few instances, the eminence on the cleft side is absent or poorly defined.
5. The relationship of the alveolar process to the lip is variable. In some, the alveolus protrudes between the cleft in the lip and overrides the lip on the cleft side. In others it is concealed by the labial elements except when the infant cries.
6. The extension of the vermilion varies.
7. The number, size and position of the lateral incisors adjacent to the cleft varies, as shown by Dickson (1966) and confirmed by Lauterstein and myself (*Teratology*, 1969). This tells us something about mesodermal adequacy and is a factor in determining the arch form.
8. In examining infants, casts and observing in surgery, I became impressed that there are aberrant insertions of labial musculature or fibers onto the nasal aspect of the maxilla which may contribute to the rotation and architectural configuration of the total complex. In a sense, my observations parallel what you wrote about the vestibular lining, except that I tried to explain the dynamics in terms of muscular tensions on developing un-buttressed structures.
Finally, I must add one other item to the check list by quoting the title from an article in preparation, "Time: The Fourth Dimension in Syndrome Analysis." All of these variables are subject to change with increasing age. A static view of deformities leads to poorly timed and sometimes unnecessary surgery. As examples, many VSD defects of the heart tend to close and the micrognathia of the Robin anomalad diminishes in severity as the child grows older.

NO. 1 PRESENT DILEMMA

An extremely difficult task which is involving the concentrated efforts of a multitude of measuring researchers, both orthodontists and surgeons, continues to be that of carefully estimating and honestly evaluating whether the final discrepancies seen in clefts are inherent or induced or both. If induced, it is important to determine whether the discrepancies were caused by the injury of surgery followed by fibrosis, or by the timing of the injury and its effect on growth or both.

NASOPHARYNGEAL AND SOFT PALATE GROWTH

Growth and development in the nasopharyngeal area are important. In 1952 E. W. King demonstrated that after 2 years of age a remarkably stable relationship exists between the posterior nasal spine of the hard palate and the anterior arch of the first cervical vertebra. He concluded that with growth there is little perceptible increase in depth of the skeletal pharynx. The forward growth of the anterior arch of the atlas seems to prevent any appreciable increase in depth. The vertical dimension of the nasopharynx normally continues to increase until 17 to 18 years of age, when the maxilla itself completes its growth. As the head grows, the hard palate moves away from the base of the skull in a gradual and parallel manner. Both nasal and nasopharyngeal height increase as a result of this descent of the hard palate. Thus the floor of the nasopharynx, the soft palate, by virtue of its attachment to the posterior border of the hard palate, is also being carried to lower levels in relation to the base of the skull.
Growth of the upper face results in a constantly changing distance between the soft palate and the soft tissues of the superior and posterior aspects of the nasopharynx. From infancy to early adulthood, Subtelny found, there is an increase in the depth of the "soft tissue" nasopharynx, the dimension between the posterior border of the hard palate and the soft tissue of the posterior pharyngeal wall. The descent of the palate serves to increase the anteroposterior depth of the soft tissue nasopharynx with a concomitant increase in the vertical height of the nasopharynx.

In the normal child, the growth in length of the soft palate was most rapid between 3 months and 2 years of age, after which minimal growth was apparent until 4 to 5 years. At that point a slow and steady growth increase was noted up to late adolescence or early adulthood.

P. J. Coccaro at the University of Rochester, from records obtained from the cleft palate center of the University of Illinois, found growth patterns of the soft palate for cleft palate children quite similar to those of normal individuals. The cleft patients were observed to have somewhat shorter soft palates. It was also noted that operated soft palates grow in length as do non-operated ones.

**ADENOID TISSUE**

The comparatively shorter soft palate length with the comparatively greater dimension through which it must move points to the importance of the projection of adenoid tissue.

In 1964 J. M. Tanner, with his source of reference the work of R. E. Scammon, J. A. Harris and C. M. Jackson et al. (1930), wrote:

The lymphoid tissue of the tonsils, adenoids, appendix, intestine, and spleen, has quite another growth curve. It reaches the maximum amount before adolescence, and then, probably under direct influence of the sex hormones, declines to its adult value.

Although in general this, for the most part, is the case, there are exceptions. In 1975 Pruzansky, with cephaloroentgenographic studies of tonsils and adenoids, attacked the statement. He found
considerable variation in adenoid size in all age groups. Some children exhibited sparse development of adenoid tissue, and in some the size of the tonsils did not necessarily mimic the size of the adenoid tissue.

In 1956, using lateral cephalometric x-rays, J. D. Subtelny and H. Koepp-Baker studied the specific cycle of growth of nasopharyngeal adenoid tissue. Early rapid growth of adenoid tissue fills as much as one-half of the nasopharyngeal cavity by 2 to 3 years of age. After 2 years of age the adenoid tissue continues to grow, still in a downward direction but at a slower rate, until its peak of growth is reached at 9 to 11 years. Evidently this peak can be reached as late as 14 to 15 years. Then the adenoid tissue commences to atrophy. By adulthood it has atrophied completely and, with maxillary growth at an end, the greatest dimension between the superior surface of the soft palate and the superior and/or posterior wall of the nasopharynx is established.

In children the soft palate was observed to move upward and backward, with velopharyngeal closure occurring against the adenoid tissue. Following adenoidecomy, greater muscular activity on the part of the soft palate was necessary for velopharyngeal closure. Not all normal palates can adjust to this loss of cushion; certainly postoperative cleft palate patients can be affected adversely. Thus it becomes obvious that adenoid tissue should not be removed routinely without good cause in the cleft palate case.

Although many cleft palate patients are known to be able to accommodate to the gradual growth and abrupt surgical changes, unfortunately, not all are able to do so. While the level of velopharyngeal closure was found to be closely related to the level of the hard palate at all ages, the soft palate usually contacted the superior aspect of the nasopharynx or adenoid tissue in the younger ages and the posterior pharyngeal wall in the older groups. As noted by Subtelny:

The changes in site of velopharyngeal closure with growth helps to demonstrate why some youngsters could have good speech at one age and poor speech at an older age. In the younger group, a soft palate that is limited in activity could contact adenoid tissue since it is closely related to this
contiguous structure. With growth, the same soft palate may not be able to move adequately to contact the posterior pharyngeal wall.

It can be simply said that no congenital cleft of the palate is exactly like another; surgical treatment varies according to the surgeon, the technique and the timing of the surgery, but all these factors have some influence on the growth and development of the affected parts. Our goal is to find a plan of treatment that will have the least deleterious effects on growth with the best effects on development toward normal appearance and function.
4. Cooperation of Plastic and Dental Teams is Vital

There have been many times in the history of plastic surgery when the dentist was a most important member of the team.

If we allegorize cleft surgeons as the law-and-order good guys fighting with principles against the bad guys, primary congenital and secondary surgical deformities, then we can flash back to Tombstone, Arizona, October 26, 1881.

At half past two in the afternoon, the Clancy brothers, the McLowrys and a tough young killer, Billy Claiborne, waited in the shadows of the fence corral. The three Earp brothers, Virgil, Morgan and Wyatt, came onto Fremont Street heading for the O.K. Corral. Each wore a black stetson and under his single-breasted black frock coat carried two Colt revolvers. Virgil also had a shotgun. On they came, the three against the five. Suddenly, a man in a flapping gray coat and carrying a cane dashed out toward them from the sidewalk. It was dentist Doc Holliday.

"Where are you fellers going?" he asked.
"To a fight," said Wyatt.
"Fine," Doc replied, "I'm in it too!"

He dropped his cane to catch the shotgun Virgil tossed to him. As they entered the corral, Marshal Earp ordered:
"You're under arrest. Up with your hands!" and the guns blazed. When the smoke had cleared, three of the outlaws lay dead and two were on the run. Only two of the Earps had flesh wounds. Doc Holliday had evened the odds and given a good account of himself that day. Gillies' Doc Holliday during World
War I was Kelsey Fry, while mine in the cleft campaign is Sam Berkowitz.

Berkowitz received his dental degree at New York University and his orthodontic training at The University of Illinois Dental School where he studied with Sam Pruzansky for two years prior to coming to Miami. He is a scholar, artist and dedicated researcher. It is not an exaggeration to say that Sam has strong opinions, does not take kindly to argument against his beliefs and, although beginning to mellow with the years, still can be stimulated to a purple color and some ranting and raving if we insist on an immediate ideal result rather than the long-term plan. He has made original contributions to his field. As stated by his mentor, Pruzansky:

Three dimensional analysis of casts utilizing stereophotogrammetry being carried out by Berkowitz (1968, 1971) provides the most sophisticated approach currently available to measure the architecture of the palate. Studies now being completed by Berkowitz et al . . . may lead to a subclassification of cleft types based on cluster analysis of architectural characteristics of the cleft palate cast.

His dedicated record taking and longitudinal study of our cases has had a tremendous influence on diagnosis and treatment of our clefts. It is important that he have his say, now:
One’s enthusiasm for a particular form of therapy should not be regarded as scientifically established when, in fact, it may not have stood up to critical scientific analysis. Treatment fads come and go; unfortunately, when they involve cleft palate it takes at least a decade to determine their effectiveness. A prior belief in a particular therapy often determines the biased selection of evidence to support a concept currently in vogue, and some clinicians show a select sample of cases to prove the theory only in part, if at all.

This chapter presents my understanding of the cleft defect and the face in which it exists. It is designed to answer some basic questions previously posed by Drs. Pruzansky and Subtelny. What is the natural history of the cleft defect? How do similarly classified clefts differ from one another? What should be done for a child with a cleft lip and palate, and when should it be done? And finally, how does the treatment vary from child to child? Although selected cases will be shown to develop our treatment philosophy, it must be stressed at the start that the concepts being presented are supported by the findings from many longitudinal facial growth studies already published. The cases offered here are somewhat unique in that they represent the results of only one surgeon who has modified his concepts according to the critical review of the results achieved. Also, no neonatal maxillary orthopedics has ever been done.

Treatment failures as well as successes are presented to develop and stress the physiological principles which are the basis of our treatment philosophies.

**Diagnostic Records**

Longitudinal facial growth records such as cephaloroentgenographs, casts of the palate and facial photographs starting at the newborn period demonstrate how surgery may influence the direction and degree of palatal development. This knowledge helps explain how different results can occur even when similar surgical techniques are being employed. It exposes the biological mechanism which ultimately determines the success or failure of reconstructive surgical procedures. This information does not diminish the importance of surgical technical skill but does highlight the many other
Ideal deciduous occlusion

The maxillary canine (cuspid) occludes between the mandibular canine (cuspid) and first deciduous molar or first premolar (bicuspid), and all the other teeth occlude in their proper interrelationship.

facets that warrant consideration in planning treatment. It permits the clinician to appreciate what great allies or adversaries he has in time and growth.

Serial cephaloentgenographs and casts expose the rate and degree to which a face and palate can improve or worsen with time. The face with a complete bilateral cleft lip and palate in this case improved as the profile became flatter.

GLOSSARY OF DENTAL TERMS

Classification of the anterior (incisal) and posterior (buccal) occlusion is based on the interrelationship of the teeth of one arch with those of the other arch. Malocclusion may be present unilaterally or bilaterally. Although there are three basic classes of malocclusion, there is a great variety of dental relationships within each type. For example, a class II malocclusion can have an anterior open bite and displaced teeth as well.

Neutroclusion (class I)

The maxillary canine (cuspid) occludes between the mandibular canine (cuspid) and first deciduous molar or first premolar (bicuspid), and all the other teeth occlude in their proper interrelationship.
Distoclusion (class II)
The maxillary cuspids are forward of their ideal position as seen in neu­troclusion. The posterior teeth are out of alignment in the same direc­tion as well. Distoclusion is often associated with severe maxillary anterior overjet and/or overbite.

Mesioclusion (class III)
This is the reverse of distoclusion. The maxillary buccal teeth are posterior to their ideal position with the mandibular teeth. The anterior teeth are usually in crossbite.

Open Bite
The teeth of opposing arches do not meet. This may occur in either the anterior or posterior portions of the arch and may be due to orofacial habits or skeletal dysplasia.

Crossbite
Crossbite may be due to malposition of the teeth alone and/or be coupled with bony displacement. Buccal crossbite in cleft palate is often caused by medial displacement of the lesser palatal segment. Anterior crossbite may be the result of dental dysplasia, mandibular prognathism and/or maxillary hypoplasia.

Pseudo class III (associated with anterior crossbite)
This state exists when the mandible is of normal size and in normal relationship with the maxilla but the anterior teeth are still in crossbite. It may be due to the retrusion of the maxillary teeth, to premaxillary and/or maxillary hypoplasia or to the forward posturing of the mandible (false prognathism) which places the lower anterior teeth forward of the maxillary teeth when in occlusion.

**Dental dysplasia**

Individual teeth are malpositioned within each arch.

**Skeletal dysplasia**

Prognathia is a condition in which the mandible is located anteriorly within the skull or is enlarged. It is associated with class III malocclusion. The maxilla may be posteriorly positioned within the skull or be underdeveloped as well.

Retrognathia is due to a small mandible (micrognathia) or to a posteriorly located normal sized mandible. It is associated with class II malocclusion. In some cases a relatively small mandible can coexist with a forward-positioned maxillary complex.

**IS THE NEONATAL UNOPERATED CLEFT LIP AND PALATE DEFICIENT IN MASS AND/OR DISPLACED IN SPACE?**

While Stark stated in 1958 that all cleft palates show mesodermal deficiency, and therefore adult cleft palates are destined to be small in size, Graber (1954) reported that growth deficiencies in all dimensions were due to early closure and to many surgical procedures. Pruzansky (1956), Slaughter, Pruzansky and Harris (1956), and Mestre et al. (1960) wrote that each cleft
The palate patient had the genetic potential for adequate facial growth. Coupe and Subtelny (1960) demonstrated that tissue deficiency can exist in variable degrees according to cleft type. The complete bilateral clefts of the palate had the greatest degree of tissue deficiency and lateral displacement of the palatal shelves. My own findings suggest that the neonatal cleft palate may be smaller in size than a normal palate of similar age, but it has the potential of reaching normal size at a later age. Also, in complete clefts the palatal segments are displaced from their normal position because of the pull of aberrant external muscular forces and the action of the tongue within the cleft pushing the segments farther apart.

Contour map of a normal palate

Contour map of a complete unilateral cleft lip and palate.

Contour map of Dizygotic twins

Effect of clefting on palatal form: The light gray area represents the difference in the width of the cleft palatal segments when compared to the normal (cross-hatching) palate.

The composite of normal and complete unilateral cleft lip and palate casts shown here graphically portrays the lateral displacement of the palatal shelves as a result of clefting and uncontrolled muscular systems.

**Influence of aberrant muscle forces on palatal segments—displacement of tissue**

Cleft of lip and alveolus

Complete unilateral cleft of lip and palate

Complete bilateral cleft of lip and palate (Slaughter et al., 1958)
Incomplete bilateral cleft lip and palate

In the molding of the facial skeleton there are complex muscular systems which influence the spatial relationships of the facial bones. The superior constrictor of the pharynx, the buccinator and the orbicularis oris muscle complex are largely responsible for molding the dental arch and opposing the expansile forces of the tongue. Muscle function is initiated prior to complete ossification of the skeleton and may manifest itself as early as the second month of life.

Since development of the palate involves two separate embryonic processes—the lip and alveolus derive from one, and the palate posterior to the incisal canal from another—it is possible to have any number of variations in degree and locations of clefting.

Incomplete clefts of lip and palate

Any soft tissue bridge (Simonart’s band) across the cleft will prevent the aberrant muscle systems from being really effective in distorting the palatal segments. For this reason it is inadvisable to lump together all types of clefts when reporting on surgical results and planning treatment procedures.

Complete clefts of lip and palate

When there is a complete cleft through the lip, alveolus and hard and soft palate, continuity of the outer muscular ring and the underlying skeletal structures is lost. Thereafter, the musculature of the cleft lip develops and functions around an aberrant skeletal foundation. The cleft musculature acts in a disproportionate and possibly asymmetrical fashion on the unfused maxillary structures and is unable to restrain the expansile forces of the muscular tongue.

Complete unilateral cleft lip and palate

In complete unilateral clefts of the lip and palate there is an anterolateral displacement of the non-cleft segment with an outward and lateral rotation of the premaxillary area adjacent to the cleft.

In the complete bilateral cleft of the lip and palate, this disturbance of normal muscular balance results in extreme forward projection of the premaxilla in relation to the facial complex. The projection is due to excessive growth at the premaxillary vomerine suture which occurs in an
Complete bilateral cleft lip and palate—original distortion corrected by molding action

Both palatal segments with their connecting perpendicular plates of the sphenoid have been displaced laterally as a result of the aberrant muscular forces. As shown in this basilar view, closing the lip brings the palatal segments, with their respective pteryoid plates, together. (Subtelny, 1955)

environment of abnormal force fields resulting from a release of lip muscular restraint. The patient whose premaxilla projects least at birth often has a better profile at the earliest age. A severely projecting premaxilla will yield the poorest immediate results irrespective of who does the surgery. This comment should not be interpreted to mean that a severely protruding premaxilla at birth is to be surgically retropositioned.

Not all palates within the same cleft type are alike. Since a single cleft type exhibits many variations, no rigid formula of treatment applicable to all clefts should be expected. Several kinds of isolated cleft palate are illustrated. The cleft may extend in varying degrees as far forward as the nasal palatine foramen, and in its lateral dimensions the cleft may be wide or narrow. Each case poses different surgical problems and therefore may influence the timing for surgical repair of cleft palate.

Clefts of hard and/or soft palate

Isolated clefts of the palate can vary in shape and extent from a slight visible notching of the hard palate to cleft extending up to the incisal canal. There may be a cleft of the uvula alone or it may include the entire soft palate without involving the hard palate.

MOLDING ACTION—MOVEMENT OF DISPLACED SEGMENTS INTO A MORE NORMAL RELATIONSHIP
The new force field created as a result of closing the lip cleft induces striking and relatively rapid changes in the architecture of the palate.

Cleft of the Lip and Alveolus

The alveolus is brought into normal approximation within a few months.

Unilateral Cleft Lip and Palate

The palatal segments in almost all instances move medially, resulting in the narrowing of the cleft space throughout its entire anteroposterior length. The posterior width of the hard palate as measured from the base of the alveolar crests is reduced even before soft palate repair is performed. Some additional molding action can occur after soft palate repair which will reduce the cleft space further, but the subsequent lessening of the cleft width is mainly due to appositional bone growth at the medial border of both palatal segments.

EFFECT OF COMPLETE CLEFTS ON THE NASAL CHAMBER

Subtelny (1955), Coupe and Subtelny (1960) and Aduss and Pruzansky (1967) showed that wider nasal chambers are due to lateral displacement of the maxillary bones in the oronasal area, and that the nasal septum is displaced in varying degrees toward the non-cleft side. Closing the lip cleft causes medial movement of the lateral processes, carrying the end of the septum closer to the mid-sagittal plane.

COMPLETE UNILATERAL CLEFT LIP AND PALATE—3 POSSIBLE ARCH FORMS WHICH CAN OCCUR AS A RESULT OF ESTABLISHING UP CONTINUITY

Pruzansky and Aduss (1964) described the three possible resultant arch forms which can occur: (1) Alveolar segments butt jointing into end-to-end contact producing a symmetrical arch form. (2) Overlap of alveolar segments produces a collapsed arch form. (3) Alveolar segments approximate, but without contact. The last may be a transient relationship; either it can end up in the overlapped relationship or the segments can approximate as a butt joint.
Newborn; unilateral complete cleft lip and palate

1. Noncontracting palatal segments

2. Overlapping palatal segments

3. Abutting palatal segments
Approximation without contact of alveolar borders

The lateral segments may fail to touch because the inferior turbinate of the lesser segment makes contact with the nasal septum. (Aduss and Pruzansky, 1967). When the inferior turbinate was removed by surgery, the lesser segment moved more medially. When the surgery was done at the age of 4 years with the maxillary buccal teeth in overjet relationship, the occlusion became more nearly ideal. The medial movement of the lesser palatal segment brought the teeth into better relationship. This result supports the belief that in complete clefts of the lip and palate the lateral segments are overexpanded and not collapsed.

Overlapped palatal segments

This geometric relationship does not necessarily signify that the teeth in the lesser segment will be in a crossbite relationship at a later date when teeth have erupted. The force of the tongue acting within the vault space can exert lateral pressure against the palatal segments causing them to move outward. Spontaneous correction of overlapped segments has occurred as long as there was an absence of restraining scar tissue. Should a crossbite
develop, it can be corrected in two or three months by means of tooth-borne expanding appliances.

*Approximation with contact of alveolar borders resulting in excellent buccal occlusion*

The lip was closed at 1 month and the soft palate repaired at 11 months. The hard palate cleft was closed at 20 months of age.

The tip-to-tip buccal occlusion of the lesser segment, first seen at 2 years of age, was still in evidence three years later. The palatal cleft was closed at 16 months.
Approximation with contact of alveolar borders even with very wide complete clefts

The initial cleft geometric form is not predictive of the subsequent palatal form.

INFLUENCE OF MOLDING ACTION AND PALATAL GROWTH ON ARCH FORM WITHOUT THE USE OF MAXILLARY ORTHOPEDICS

Palatal growth

Palatal tissue has the potential of growing to normal size even though at the newborn state it may appear to be excessively small. However, it must be stressed that although the potential does exist for the palate parts to catch up and become the size one would ordinarily expect at later ages, such growth does not always take place either because of surgical disturbances of growth centers or in rare instances because of deficiency in osteogenic tissue.
There are no known geometric or quantitative parameters that can be used to predict the ultimate palatal form even when the same surgical procedures are used.

Increase in palate size occurs spontaneously and at unpredictable times and rates. It is our belief that the palate processes have an innate potential to increase in size and cannot be stimulated to grow larger than nature intended. The change in size may occur early in some cases and later in others, but in most instances it will occur and the palate eventually becomes the size necessary to close the cleft space rather easily.

Our clinical findings demonstrate no correlation between the original width of the cleft and the resultant arch form. The amount of tissue undermined in closing the lip may play a small role in determining the ultimate relationship of the palatal shelves, but we are not certain of all the factors involved. There seems to be a contradiction to the findings that wider clefts show a greater tendency toward collapse than did the narrower clefts which were already in a "state of collapse" prior to the lip surgery.
Timing of palatal closure

Much emphasis has been placed on the need to close the hole before the age of 2 years. Unfortunately, age of closure is proposed as the main consideration for the achievement of proper speech production in later years. Timing of palatal closure should be governed by the size of the palatal cleft in relation to the size of the palatal shelves. Although in some cases it is preferable to close the cleft space before 2 years of age, in other instances it is best to wait until 3 or 4 years of age. We believe that poor speech production is due to many other factors than the mere age when cleft closure is performed.

Longitudinal growth studies support the contention that there is no optimal age for repair of the cleft palate. "Timing is an individual matter and is related to the anatomical and functional assets present in the patient." These studies show that a well-designed surgical procedure which is ill timed may lead to long-term failure. Conversely, a technically inferior procedure performed at a proper time can yield superior results.

Rapid reduction of cleft space in isolated cleft palate

Early reduction in the cleft space dimensions makes it possible to close the palatal cleft at 10 months without creating growth-inhibiting scar tissue. In some instances it may be advantageous to postpone palatal surgery until 2 or 3 years of age in order to allow for an increase in palatal tissue relative to cleft space.
UNILATERAL CLEFT LIP AND PALATE—ADVERSE EFFECT OF EXCESSIVE PERIOSTEAL UNDERMINING PERFORMED AT AN EARLY AGE

In this case excellent arch alignment and closure of the cleft space resulted from molding action and palatal growth.

Three months after "island flap" palatal lengthening, there was a buccal crossbite of the left lesser palatal segment. Note the slight transverse palatal scar.

A fixed palatal expander was used to correct the crossbite; correction accomplished in three months. A fixed palatal retainer was necessary to maintain the new arch form. In the absence of palatal scar tissue the expansion need not always be retained by a transpalatal arch. The determining factors are the relationship of the palatal segment and the amount of scar tissue.
The retainer was lost. The transverse scar is very prominent and has drawn the involved teeth medially, causing an hourglass-shaped palate. The adverse effect is also seen in the developing anterior cross-bite and crowding. Maxillary development was adversely affected in all three dimensions.

CORRECTION OF MEDIAL COLLAPSE OF PALATAL SEGMENTS BY ORTHODONTIC EXPANSION—DECIDUOUS OR EARLY MIXED DENTITION

In complete clefts of the lip and palate, the united orbicularis oris, buccinator and superior constrictor pharyngis muscle ring mold the palatal segments which have been displaced outwardly and upwardly by aberrant

Various fixed palatal expansion appliances
muscle pull. Narrowing of the palatal cleft occurs throughout the entire anteroposterior length of the palatal segments from the incisal papilla to the maxillary tuberosities. This action has been found to take place not only after lip repair but also after soft palate surgery.

When the alveolar process of the smaller segment becomes contained within the premaxillary alveolar element of the larger segment, a dental crossbite occurs between the maxillary and mandibular teeth. Dental dysplasia may or may not coexist with segmental dislocation.

Correction of a crossbite in the deciduous dentition has been shown to improve dental function, nasal respiration, maxillary alveolar development, speech development and facial aesthetics.
The closed left maxillary lateral incisor space was recovered and a normal anterior overjet and overbite relationship established after two years of orthodontic treatment. The missing tooth was replaced, and the buccal segments were retained with a fixed dental bridge which spans both sides of the cleft.

Orthodontic therapy is directed toward counteracting the muscular influences created by lip surgery. An outward-directed force establishes a more normal arch form and widens the nasal cavity. This movement carries the inferior turbinate with it, increasing the distance from the nasal septum (Aduss and Pruzansky, 1967).

**AN ANTERIOR DENTAL CROSSBITE IN AN ADULT DOES NOT SIGNIFY PRESENCE OF A HYPOPLASTIC MAXILLA**

Maxillary dental dysplasia can be due to faulty eruption patterns associated with hypertonic lip and cheek musculature. A non-scarred palate permitted the expansion and advancement of the buccal and anterior teeth with less concern for future relapse.

The closed left maxillary lateral incisor space was recovered and a normal anterior overjet and overbite relationship established after two years of orthodontic treatment. The missing tooth was replaced, and the buccal segments were retained with a fixed dental bridge which spans both sides of the cleft.
The ability to advance the maxillary incisors into a proper overjet relationship is the most reliable means for evaluating basal bone adequacy and normal maxillary development.

The left lateral incisor space was opened to receive a tooth of equal size as the right lateral incisor. A maxillary fixed bridge was created to replace the missing tooth and maintain the palatal segmental relationship. Placement of teeth in their proper relationship is dependent on palatal segment relocation as well as tooth movement.

Improvement in soft tissue profile was achieved after the teeth were relocated and the lip and nose revised.
Classification based on the presence or absence of soft tissue attachments

Complete bilateral cleft of lip and palate with a severely projecting premaxilla

Bilateral cleft lip with or without palate. Why does the premaxilla protrude ahead of the palatal shelves?

Which of three mechanisms is operative? (1) There is an overgrowth of the premaxillary-vomerine complex response to altered muscular physiology, the result of unrestrained growth at the premaxillary-vomerine suture. (2) The projection of the premaxilla is an illusion created by underdevelopment or retroposition of the palatal shelves associated with micrognathia or retrognathia. (3) A combination of the above factors is in effect.

Recent research has reported that the complete bilateral cleft lip and palate deformity is characterized by an overgrowth or excess of mesoderm at the premaxillary-vomerine suture (Pruzansky). Our own clinical research using serial casts and roentgenographs refutes Burston’s earlier statements (1958) that

The bilateral condition is characterized by two retroplaced and small maxillae. The central stem of the premaxilla is relatively protrusive. It should be noted that although this latter element may be somewhat rotated in an upward direction, the actual amount of true over-development is often quite limited and the major defect lies in the retroplaced maxillae.

The incomplete bilateral cleft lip and palate shows relatively less geometrical distortion to all three palatal segments, whereas the complete bilateral cleft of the lip and alveolus with or without palate is characterized by an extreme forward projection of the premaxilla and in relation to the facial complex. When the cleft includes the secondary palate as well, the palatal segments are laterally positioned to varying degrees of distortion. In complete bilateral clefts the prominent premaxilla has long been recognized as one of the principal obstacles to successful bilateral lip and palate repair. However, time is an ally, and the singular lesson that has been learned from serial growth studies is the need to be patient and allow the palate and face to grow and develop at their individual rates.

Variation in geometrical relationships and size of premaxillary segments

Any number of geometrical variations can exist between the palatal shelves and the premaxilla. For these and other reasons the molding effect of lip repair on the palatal segments and the resulting palatal form will vary from one case to another.

The size of the premaxilla is determined by the number of tooth buds it contains. There may be one, two, three, four or even five buds, either with one or both permanent central incisors alone or with one or both lateral
Variations in size and relationships of the premaxilla to the palatal segments at the newborn period

Small premaxilla projecting ahead of large palatal segments due to the presence of four deciduous and four permanent tooth buds. The lateral palatal segments have not been displaced because of their attachment to the nasal septum.

incisors. These teeth are sometimes malformed or displaced from their normal position. In rare instances there is only one central incisor, the other being malformed or even missing. In some cases the palatal segments contain extra deciduous and permanent lateral incisors on either side of the cleft. If they are present on both sides of the cleft, the premaxilla may appear to be much wider than the available space between the palatal shelves. This situation can create the illusion that the palatal segments are in crossbite when in fact they may be in excellent relationship.

Geometrical changes resulting from molding action (Rapid closure of cleft space in incomplete bilateral cleft lip and palate.)

It is not possible to predict the final form of the maxillary arch (the relationship of the premaxilla to both palatal shelves) according to the original size and/or geometrical relationship of the three parts. The premaxilla in complete bilateral clefts may in some instances fit within the

1 week of age before surgery
palatal shelves, but usually it is finally positioned forward of them. For the palatal shelves to fall behind the premaxilla does not signify that they are medially displaced and the teeth will be in crossbite. Only in rare cases will the three segments come together in perfect arch alignment.

Both cephaloroentgenographic and cast analysis demonstrate that lip reconstruction or the use of external traction brings almost immediate reduction in premaxillary projection because of ventriflexion, the fulcrum being the premaxillary-vomerine suture. Septal buckling has been demonstrated in my computerized tomography studies. Marked facial change and reduction in the anterior cleft space result from the ventriflexion.

The figures demonstrate that excellent arch alignment can occur within the first year irrespective of the degree of premaxillary projection and lateral palatal distortion. In each instance the premaxilla came in contact with the lateral palatal processes although lying well forward of the lateral palatal shelves in the initial state.

**THE CONCEPT OF "CATCH-UP GROWTH"**

The surgeon, when planning the habilitation of a newborn with a complete bilateral cleft lip and palate, must rely heavily on the following facts:

1. At birth, all three palatal segments are geometrically distorted, but after lip surgery the molding action will bring the segments into a more normal relationship.

2. Uniting the lip will reduce premaxillary projection by ventriflexion with or without septum buckling. The profile can continue to flatten because of differential facial growth.

3. Further molding coupled with palatal growth will continue to reduce the remaining cleft space to more manageable proportions.

4. The inherent facial pattern will ultimately determine the handling of the premaxilla.

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3 months. Medial movement of the palatal shelves plus palatal growth reduces cleft space.

8 months. Medial movement and growth to all three segments further reduces cleft space.

Two-stage lip repair

21 days  
3 months; left lateral flexion of the premaxilla  
8 months; the premaxilla is now centered due to the pull of the united lip musculature
SERIAL GROWTH CHANGES TO THE COMPLETE BILATERAL CLEFT LIP AND PALATE (after one- or two-stage lip repair)

When judging palatal growth changes from casts, one must visualize an imaginary line (F-F) connecting the posterior end of each alveolar crest as the baseline from which to view anteroposterior growth. This line connects palatal landmark points which are comparable to cephalometric landmarks PTM (pterygomaxillary fissure) and marks the junction between the hard and soft palate.

Some workers have said that the lateral palatal segments, since they are detached from the nasal septum, are deficient in size (McNeill-Burston). It is my belief, acquired from looking at many serial casts, that, although the palates look smaller at the newborn period, they grow very rapidly and may approach normal size by the age of 3 years.

Superimposing three palatal stages of the previous series

Outlines of the first, fourth and fifth cast of the above case are superimposed on the line representing the posterior limit of the hard palate. Point Z is the registration mark for superimposition purposes only. The following conclusions can be drawn from this and other palatal growth studies; they demonstrate the limits of predictability of palatal change.

1. The premaxilla shows little anterior movement after lip repair. The repaired lip appears to retard the forward growth of the maxillary complex, thus contributing to the flattening of the facial profile.

2. The lateral palatal segments demonstrate excessive anterior and medial growth. The anterior growth rate exceeds that at the medial border. The three-dimensional surface area of the lateral palatal segments doubled in 1\(\frac{1}{2}\) years. Between 1\(\frac{1}{2}\) and 3\(\frac{1}{2}\) years there was an additional 25 percent increase in surface area.
3. The premaxilla surface area changed only slightly during this same time span.

It is important to reemphasize that the geometrical palatal changes depicted here can be predicted in the majority of other patients. Exceptions are rare. Should the lateral palatal process fail to catch up to the premaxilla, then and only then should one consider surgical setback.

Why should the clinician want to set the neonatal premaxilla back to relatively smaller lateral processes when all the evidence indicates that within three years these same segments grow forward to reach the premaxilla? Friede and Pruzansky (1972) have shown that when the distance between the palatal shelves and the premaxilla exceeds 25 mm, a poor prognosis exists for conservative premaxillary handling and a retraction of the premaxilla is in order. The timing for the retraction is determined by many factors.

THE PROFILE IN COMPLETE BILATERAL CLEFT LIP AND PALATE

Any number of geometrical permutations may exist between the maxilla, the mandible and the cranial base which will affect the profile. Cephalometric facial growth studies have shown that the skeletal profile becomes less convex with age because of profile remolding brought on by various growth increments to the upper, middle, and lower face.

Good facial growth occurs where the facial profile flattens with time, and the angle of facial convexity as measured by N α Po' becomes more obtuse. This change is brought about mainly by the greater increment of forward growth of the chin point (Po') relative to the upper (N) and mid-face (α) points. As already stated, lip repair over the projective premaxilla appears to retard the forward remodeling of the maxillary complex (Berkowitz, 1959).

The final profile characteristic will depend on whether the face is prognathic, mesognathic or retrognathic. In different individuals the same bone or group of bones may grow at different rates and at different times. In some
the same bone will grow rapidly and attain its full potential at an early age while in others it will grow more slowly but for a longer period of time.

The evaluation of success or failure of surgery cannot be made on aesthetic grounds alone and must be postponed until facial growth is nearly complete.

Good facial growth

The change in the profile was rapid on account of excellent mandibular growth and upper face development. The profile (angle of facial convexity) changed approximately 30 degrees within 1½ years.

Poor facial growth pattern

A disharmonious facial pattern represents the extreme of facial variation as seen when the premaxilla protrudes in a retrognathic face. Most faces show a growth pattern leading to reduction in profile convexity, the greatest change occurring during the first year of life. Although mandibular prognathism is the extreme of facial variation in the opposite direction, when found in complete bilateral cleft patients it may be beneficial.

Good palatal growth pattern

One cannot predict at an earlier age what the final profile will be. The continuing flattening of the profile until adulthood is a common occurrence. This reduction in facial convexity is mainly due to differential mandibular growth.

Poor palatal growth pattern
When poor palatal growth pattern coexists with a poor facial growth pattern, the profile is placed in double jeopardy and retraction of the premaxilla is warranted.

In complete bilateral cleft lip and palate the distance between the lateral palatal shelves and the premaxilla is a measure of the palatal deformity. If it is excessive at 5 years of age—that is, if the premaxilla is not in contact with the palatal segments—one might have to consider surgical setback at some later date. The ultimate decision is made only after the profile is evaluated as well.

In this case the serial profile tracings showed that the premaxilla needed to be surgically set back since it was demonstrated that there was no further reduction in the angle of facial convexity (N α Po').

**Good palatal growth pattern**

Rapid resolution of the palatal deformity was achieved by molding action and good palatal growth within the first year.

Sequences of molding action brought on by uniting the lip, resulting in almost perfect arch alignment.

4 years 9 months. Soft palate closed at 8 months. Slight crossbite of the right side. No overjet but steep overbite.
Incomplete bilateral cleft of lip and palate left side and complete cleft of lip and palate right side. Good palatal growth pattern

Rapid resolution of the palatal deformity was obtained. The most laterally displaced palatal segment was moved medially and the premaxilla rotated into proper relationship. This movement, coupled with appositional palatal growth, markedly reduced the cleft space. The teeth on the most laterally displaced left segment ended up in a slight crossbite which will be easily reduced with a fixed expander. Correction of the buccal crossbite is dependent on the movement of the entire lateral palatal segment. The correction will have to be maintained by a fixed retainer until the permanent teeth erupt. After final orthodontics, a permanent bridge will be used to replace the missing teeth and to maintain proper arch form. Bony fixation of the palatal segment is, therefore, not essential. Facial growth studies have shown that primary bone grafting has interfered with maxillary development and has failed to maintain arch form.

5 years; after three months of orthodontic treatment. Bilateral buccal expansion using fixed toothborne appliance. Crossbite corrected by moving the palatal segments laterally.

6 years. Deciduous lateral incisors were extracted to permit improved premaxillary alignment. Palatal cleft was closed with no adverse effect to the palatal architecture.

Comments: The severe premaxillary overbite doesn’t pose any functional problems. It will be corrected by orthodontic means in the permanent dentition.

16 days 3 months 1 year 6 months
Comments. The possibility that a crossbite might occur at 2 years of age does not justify neonatal orthopedics.

Complete bilateral cleft of lip and incomplete cleft of palate on both sides

The palatal segments, which at first appear to be collapsed medially, are actually in an excellent relationship with the premaxilla. This case dramatically demonstrates the strong potential for palatal molding and growth to reduce the initial geometric disproportion.
Correction of an anterior open bite due to a superior displaced premaxilla in a bilateral cleft lip and palate patient

As the face grew and developed the surgically repositioned premaxilla, which was separated from the vomer at an early period, and detached from the lateral palatal segments, ended up displaced high in the nasal chamber. As the premaxilla failed to descend away from the cranial base along with the palatal segments a skeletal anterior open bite resulted. The buccal segments ended up in crossbite as well.

Comments: The displaced deciduous lateral incisors were extracted to permit the premaxilla to butt up against the lateral palatal segments spontaneously. The palatal cleft is almost completely closed by appositional growth. Except for a slight tip-to-tip left buccal occlusion, the dental relationship is excellent. The overbite will be reduced by orthodontia at a later date and poses no functional problem.

1 year 8 months. The displaced deciduous lateral incisors create an illusion that the segments are collapsed.

2 years 3 months. The cleft space is markedly reduced; there is slight buccal crossbite of the left segment.

2 years 11 months

5 years 6 months. Before orthodontic treatment.
As soon as the permanent maxillary central incisors erupted, orthodontics was instituted to reposition them into a normal overbite-overjet relationship. The buccal segments were moved into proper occlusion at the same time.

7 years 6 months.

15 years. After final orthodontics.

15½ years. Fixed bridge inserted.
Final orthodontic treatment involved the removal of all first bicuspids in order to uncrowd the posterior teeth and to align the maxillary anterior teeth into proper overbite-overjet relationship. The left lateral incisor was moved into proper position even though a bone graft was not inserted in the line of the cleft. The right lateral incisor was congenitally missing and its space maintained for a false lateral incisor to be inserted later.

A maxillary bridge was placed between the right and left second bicuspids in order to stabilize the maxillary segments and replace the missing right lateral incisor. Relocation of the palatal segments were dependent upon the absence of restricting palatal scar tissues. Note the excellent vault space which permits normal tongue position and speech articulation.

The excellence of this result does not support early premaxillary retropositioning.

**Surgical Premaxillary Retrusion**

*Premaxilla surgically set back in late deciduous dentition*

Because of the severe facial deformity and consequent malocclusion, it was decided that premaxilla setback should be immediately performed, without waiting for the permanent dentition. The objective was to eliminate the anterior cleft space and to bring the premaxilla into physical contact with the palatal segments. The premaxilla was to be stabilized in 4 years, severe overbite and overjet.
three dimensions to allow for a possible bony union with the lateral segments. A removable prosthesis was used for fixation. In my experience a *Kirschner wire* not only fails to stabilize the premaxilla in any dimension but often causes deformations to the central incisors. Its use for any purpose should be abandoned.

Use of a wire to stabilize the premaxilla (?!) Immediately after insertion and 6 months after removal. The wire penetrated the dental developmental sac, disrupting the formation of the central incisors.

Bands with lugs were placed on the deciduous molars to increase retention capabilities. A working maxillary cast was made and the premaxilla cut and repositioned against the palatal segments. Care was taken to place the premaxilla in proper geometrical position so that a normal overjet-overbite relationship resulted. A combination acrylic and steel prosthesis was fabricated, allowances being made for tissue swelling. The prosthesis was inserted at the time of surgery and worn for three months. It was removed only to maintain cleanliness. At the end of this time the premaxilla became semi-rigid because of unilateral ossification with the palatal segment.
In a case of complete bilateral cleft lip and palate the lip was repaired at 1 month and the soft palate was united at 12 months of age. The deciduous lateral incisors are displaced medially. Although the palatal segments appear to be collapsed when they are related to the wide premaxilla, the occlusion shows them to be in excellent buccal relationship. A moderate-sized palatal cleft remains.

Three months after surgical setback the overjet-overbite relationship appeared to be stable. There was some slight ventriflexion to the premaxilla which posed no long-term functional problem.

Poor palatal growth with a poor facial growth pattern

In a case of complete bilateral cleft lip and palate the lip was repaired at 1 month and the soft palate was united at 12 months of age. The deciduous lateral incisors are displaced medially. Although the palatal segments appear to be collapsed when they are related to the wide premaxilla, the occlusion shows them to be in excellent buccal relationship. A moderate-sized palatal cleft remains.
Presurgical palatal and facial evaluation and palatal preparation

The premaxilla is to be set back because the anterior cleft space has failed to reduce and is associated with a poor facial growth pattern. The anterior positioned mid-face complex, coupled with a retrusively growing mandible, has created a severe facial convexity. This profile characteristic appeared to be stable at 6 1/2 years of age.

Even with the buccal segments in good occlusion, the arches were overexpanded prior to surgical premaxillary setback in order to permit premaxillary repositioning within the palatal arches. This buccal expansion is not permanent, and it is anticipated that the arches will return to their original position as a result of muscle-molding action.

After premaxillary setback and closure of the palatal cleft

Deciduous lateral incisors were removed and the premaxilla set back. A slight overbite and overjet was established to allow for differential mandib-
A bilateral cleft lip and palate.

Arch form and size are excellent after reestablishment of lip muscle continuity. Palatal increase in size by appositional growth has further reduced the cleft space. This growth capability is inherent in all cleft palates and will occur but at various times and to various degrees.

The excellent dental relationship has stabilized.

**DELETERIOUS EFFECT OF NON-PHYSIOLOGICAL SURGERY**

* A bilateral cleft lip and palate

Arch form and size are excellent after reestablishment of lip muscle continuity. Palatal increase in size by appositional growth has further reduced the cleft space. This growth capability is inherent in all cleft palates and will occur but at various times and to various degrees.
Extensive periosteal undermining performed in an "island flap" procedure at the age of 20 months resulted in severe scarring. The buccal crossbite and anterior incisal relationship reflect the growth-inhibiting effect. Cephalometric analysis demonstrates that growth inhibition occurs in the vertical dimension as well. This case is now an orthodontic nightmare and may require a Le Fort I advancement.

Premaxilla setback followed by palatal cleft closure resulting in scarred, deformed vault.
4 years 6 months. Excellent buccal occlusion. The lateral incisors were to be extracted prior to surgical setback.

5 years 6 months; after repositioning of premaxilla.

7 years. Right buccal crossbite; asymmetrical tapered palatal arch.

Comments. The palatal cleft was surgically closed at 6 years. Palatal fistula closure at 6½ years necessitated periosteal undermining. The resulting scar contracture deformed the palate causing dental crossbite.
An island flap will not cause palatal deformation if applied on a well-developed palate with adequate tissue and if the lateral incisions are made at least 5 mm. medial to the dentition. (Charles Kremenak was the first to appreciate the need to keep the surgical incision away from the teeth.)

**NORMAL PALATAL ARCH DEVELOPMENT AFTER A REVAMPED ISLAND FLAP PROCEDURE WAS PERFORMED AT FOUR YEARS OF AGE**

*Palate and occlusion analysis*

3 years; before surgery. Ideal occlusion. Slight incisal tip-to-tip contact may be due to hypertonicity of the lip musculature.

4 years 6 months; one year after island flap surgery. Good occlusion still present. After island flap, normal arch form.

6 years 6 months; 2 years 6 months after surgery. Good occlusion and palatal development. Excellent arch form.
IN CONCLUSION

These concepts of orofacial growth present a logical sequence of treatment steps based on the natural history of cleft palate and the face in which it exists. Although the surgeon would like to get on with it and close the cleft space as soon as possible, he must temper this urge with the realization that “Time is an ally” to his reconstructive procedure.

Treatment guidelines can be listed as follows:

1. In complete cleft of the lip and palate the palatal segments are laterally displaced in space.
2. Uniting the lip and soft palate causes medial molding of the displaced segments to a more normal anatomical relationship.
3. The palatal processes have the potential to grow and develop to normal size and shape albeit at a somewhat later date.
4. Non-physiological surgical procedures can inhibit palatal growth and cause structural deformation.
5. Timing of surgical procedures must be related to the assets and deficits presented by each case and varies within each cleft type, as well as with the facial growth pattern.
6. The same surgical procedure can yield different results. What might be successful in one instance can be disastrous in another.
7. The surgeon does not always have complete control of the habilitative outcome.
8. Velopharyngeal capability is related not to the degree of palatal distortion or cleft type but to the pharyngeal architecture and to the size and activity of the velum. This functional relationship can change with time.

The 1977 State of the Art in Cleft Palate report sponsored by the American Cleft Palate Association reviewed the recent dental literature and stated that there is no data to support neonatal maxillary orthopedics with or without primary bone grafting. Although it has been well established that palatal segments can be manipulated, the long term utility of the procedures has still not been proven. It has been suggested that since retention problems associated with maxillary arch alignment are a major problem, arch correction should be postponed to when tooth-borne appliances can be used. No data has been published supporting the belief that the overlapping of the palatal segments for 3 to 5 years is detrimental to palatal growth or speech development.

Since all the statements in this chapter are supported by published facial growth studies, we need not reinvent the wheel by redoing the same studies. It behooves the surgeon to document his own cases so that he can critically review his results and ask the right questions: Why did the case turn out well or why did it fail? Progress can take place only when the correct answers to these questions are uncovered.
FUTURE STUDIES

As a result of the development of an accurate automatic non-contact three dimensional measuring device, called an optical profilometer, I intend to investigate various research problems which, heretofore, have not been explored due to the absence of a proper measuring instrument. Stereo-photogrammetry is an excellent system but it can be too expensive for our purposes. Hopefully, this investigation into changing palatal form and size under the influence of growth and surgery will lead to the development of a new cleft palate classification system which would be predictive of future palatal size and shape.

The optical profilometer concept consists of an optical system and photodetectors which observe the change in the energy distribution of an image spot of light as a function of the depth of the sample surface at the measurement point. The sample surface is scanned to provide measurement information over the complete surface. It can measure a cast within an accuracy of ±4 mm in all dimensions in 9 minutes.

By the pooling of quantitative data from a number of cleft research centers which already have a great number of palatal casts in storage we will be able to significantly increase our data base. This will enable us to arrive at more meaningful conclusions about the natural history of cleft palate development.

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Graphic display of data

Dr. Berkowitz is setting a palatal cast in the moving carriage of the optical profilometer. Immediately behind the optical profilometer is the voltage adjustment console, and on a shelf above the console there is an "Intellec #4" mini-computer. To the right of the console a "silent 700" terminal-printer is used to control the instrument's operation and will print a graphic display of the data. The data is simultaneously stored on a tape for analysis by a larger computer.
CLEFT palate has long been associated with ear disease and hearing loss. In 1878 A. Alt was the first to mention a case of otorrhea in a deaf-mute patient with a cleft palate. He closed the cleft, and the otorrhea healed. The patient was able to hear again and then learned to speak.

Conductive deafness associated with cleft palate has been reported to occur in between 27 and 50 percent of patients: Halfond and Ballenger, 50 percent; Nylén, 40 percent; Skolnik, 39 percent; Pagnamenta, 30 percent; Spriestersbach, 29 percent; and Meissner, 27 percent.

Possible causes considered in this association of cleft palate and ear disease have varied among repeated infections following the lack of an intact palatal partition between the oral and nasal cavities, disturbance by the cleft of the normal muscle physiology necessary for adequate Eustachian tube function, timing and type of surgery, scarring after surgery, effect of hamular fracture, actual abnormal Eustachian tube anatomy, and cranial base deformity.

REFLUX

The presence of a cleft in the palate was thought to allow reflux up the Eustachian tube causing otitis media. Even when treated with antibiotics without drainage, the purulent material was merely converted to a sterile exudate which remained as a foreign body resulting in conductive hearing loss.
LACK OF MUSCLE FUNCTION

As more thought and research were directed to this problem, blame was laid on the abnormal insertions of the musculature which, disrupted by the cleft, prevented normal action and adversely affected the function of the Eustachian tube. Surgeons started to look to closure of the cleft in the palate as early as possible as a step toward partially improving the muscle function.

EARLY SURGERY ADVOCATED

In 1960 Frank Masters, Hal Bingham, and Dave Robinson of the University of Kansas Medical Center began to study hearing loss in cleft palate patients and added normal hearing to normal speech and normal facial growth as goals of cleft palate treatment. They deduced:

The chronic recurring middle ear infection with its subsequent audiometrically detectable hearing deficit is a manifestation of altered eustachian physiology which in the cleft palate child is almost inevitable as the extrinsic musculature of the eustachian apparatus is not intact. Thus, early restoration of the dynamic physiology of the eustachian apparatus by creation of a normal muscular insertion appears to be the best method available to reduce the appalling incidence of hearing loss.

TREATING THE EAR DISEASE ITSELF

In 1954 Beverly W. Armstrong of Charlotte, North Carolina, first described insertion of pressure equalization (PE) tubes to maintain aeration following myringotomy, aspiration and tympanostomy for middle ear fluid.

In 1966, in the Cleft Palate Journal, James Donaldson of the University of Washington, Seattle, published an illustration of insertion of the Silastic tube after myringotomy, with the inner flange passing through the tympanic membrane and the outer flange securing it in place. He reported that, out of 702 cleft palate patients examined, 98 (13.9 percent) had middle ear pathology requiring one or more myringotomies. The infant was not suspect, but ages ranged from under 1 up to 15 years, with the largest number in the 3- to 4-year period. To establish middle ear aeration in these patients with inadequate Eustachian tube
function he advocated insertion of Silastic tubes. Although the tubes tended to be extruded sooner than desired, temporary middle ear aeration frequently improved the appearance of the tympanic membrane, allowing it to assume its normal position rather than a retracted one.

EAR PATHOLOGY IN THE INFANT

Still no one suspected ear pathology in the infant. In 1958 Skolnik had stated that the incidence of pathology was 6 percent in cleft palate children younger than a year old and increased to 60 percent in preschool children.

In 1967 Sylvan E. Stool and Peter Randall at the Children's Hospital, Philadelphia, reported on bilateral examination of the middle ears of 25 cleft palate infants under general anesthesia through a binocular operating microscope after myringotomy. Ninety-four percent of these ears contained mucoid material, and each of 10 biopsy specimens revealed the presence of granulation tissue. They suggested:

A reasonable approach to the problem of otitis media in the cleft palate infant is to examine these patients with magnification whenever they are having reconstructive surgery. The removal of abnormal material from the middle ear and the ventilation of this cavity should allow pneumatization of the ear to proceed in a more normal manner and should aid significantly in preventing subsequent hearing loss.

Interested in how it all began, I asked Peter Randall, who had long been concerned with the miserable problems of draining ears in children with clefts and the difficulty of finding cooperative otolaryngologists. Here are his reminiscences, written to me in 1973:

On September 11, 1963, Sylvan arrived on the scene. As you know, he is a somewhat rotund, jolly genius who had gone from medical school in Texas through his Pediatric training in Seattle, Salt Lake City and Boston and through a complete Otolaryngology residency at the University of Colorado in Denver. Sylvan arrived in Philadelphia fresh out of his residency being Board qualified in both Pediatrics and Otolaryngology with a lot of enthusiasm, absolutely no practice whatsoever and a perfectly beautiful, brand new Zeiss operating microscope. The day after he arrived we had our big monthly Cleft Palate Clinic and Sylvan—who had wondered how long it
would be before he saw his first patient—found one ear after another with problems beyond description. He described it as an "Otolaryngologist's Paradise." Within a very few days, he was in the operating room pushing his new Zeiss scope from one room to another asking me if I would mind if he looked at the ears of a child whose cleft lip I was about to tackle. This was the first time we had even thought of looking at the ears in an infant this young (about three months of age), and I thought he was really just trying to get experience with his new operating room toy. The child had had no known trouble with his ears, but Sylvan immediately said, "Oh my gosh, look at this!" which I did but frankly I didn't see very much. Then he asked if I would mind if he made a little hole in the eardrum and I asked how little was a little hole and why he wanted to do it, and he said that it was very little, would heal very quickly, and the reason was that he was sure there was a lot of trouble behind that particular drum. I shudder to think of my lack of informed consent, but under the circumstances it seemed that this would be the best thing to do for that child at that point. After myringotomy he began sucking out thick, inspissated, mucoid "glue." I thought that he had opened into a mucocele. He then asked if I would mind if he looked at the other ear which I readily agreed to, and the same problems were found on that side as well.

As luck would have it we had a second cleft lip to follow in the next room, and it wasn't long before Sylvan was asking if I would mind if he looked at that child as well. At that stage of the game we were taking Silastic intravenous catheters and cutting them into small pieces to use for insertion in the myringotomy openings. The various "buttons" were not yet available at Children's Hospital.

We were soon misled by a child whom we examined at about six weeks of age and actually found granulation tissue within the middle ear space, which led us to believe that much of this material was infected. However, Charles Bluestone has since shown that virtually all of it is not infected in these infants. We set out to try to study the incidence, and couldn't really figure out how to get a "control group." Then one day, I pulled a dirty trick on Sylvan and asked him to look at the ears of a child who had a cleft of the lip but no cleft of the palate. After he did the myringotomy and found that this was a perfectly normal drum with an air-containing middle ear space, he asked, "What is the matter with this child? His ears are perfectly all right." Then it was obvious that our control group should come from those patients with clefts of the lip only. We found that 87% of our infants with cleft palate had thick inspissated mucus in their middle ear space and only about 28% of those with clefts of the lip only had any kind of fluid in the middle ear space and this was usually quite watery.

Buddy Bluestone had been working along the same lines with Jack Paradise at Pittsburgh, but I'm fairly sure it did not antedate our work in
1963. It’s interesting that they came up with the same incidence figures exactly that we had, but they carried it one step further in that they brought back the children who did not have the mucoid material in the middle ear on one and even two successive occasions and showed that eventually 100% of these children get into trouble with collection in the middle ear space. Bluestone has done a very careful study of the fluid, its characteristics and studies on the Eustachian tube.

Almost simultaneously, the team of Paradise and Bluestone had directed its interest toward this ear problem. Jack L. Paradise, pediatrician at the University of Pittsburgh, in an occasional escape from crying babies, soothes his nerves by restoring antique oriental rugs. Enticed into the Cleft Palate Clinic by Betty Jane McWilliams to look into the problem of feeding and nutrition in young cleft infants, he consistently discovered bilateral secretory otitis media.

C. D. Bluestone, Alpha Omega Alpha at the University of Pittsburgh School of Medicine, became interested in the cleft palate problem in 1959 by Sam Pruzansky, while interning at the University of Illinois. In 1964 he joined the cleft palate team as otolaryngologist at the University of Pittsburgh and by 1966 was confirming Paradise’s findings by myringotomy with an operating microscope. In 1969 Paradise, Bluestone and Felder reported the universality of otitis media in infants with cleft palate:

Bilateral secretory or suppurative otitis media was found without exception in 50 infants with cleft palate 20 months of age or younger. By contrast, in a group of 100 infants without cleft palate chosen at random, otitis media was present during 22 percent of 274 clinic episodes they experienced during an 8-month period. . . . Infants with cleft palate who received myringotomy and suction, but without insertion of plastic tubes, developed early re-accumulation of fluid which required repetition of surgery. The course of infants who received myringotomy with tubes was generally satisfactory; but in some, otorrhea, early extrusion of tubes, or both occurred.

Chronic secretory or suppurative otitis media probably develops in all infants with cleft palate, and usually within the first month of life. In such infants, myringotomy accompanied by the insertion of tubes appears to be the best method of treatment now available. This procedure may be performed promptly and repeated as often as necessary to maintain middle ear aeration. It is hoped thereby to avoid the scarring, ossicular damage, cholesteatoma, or suppurative intracranial complications which otherwise
might eventually develop in some patients. Also, if surgery is not performed, hearing impairment will probably persist throughout infancy or longer, with untoward effects on well-being and function and with serious implications for intellectual, speech and emotional development.

Then Jack Paradise in 1970 studied 200 children under 12 months of age—100 with cleft palate, 100 without clefts. He found serous fluid in the middle ear in 100 percent of the cleft and 20 percent of the non-cleft children.

Also in 1970, Joyce Heller, Irving Hochberg and Gastone Milano of Newark State College, Union, New Jersey, studied 60 cleft palate and 60 non-cleft palate children aged 3 to 12 years. They found:

Cleft palate children have significantly poorer hearing sensitivity than non-cleft children, but all threshold deviations were within normal hearing limits for both.

There was an improvement in hearing sensitivity in both cleft palate and non-cleft palate children as a function of increasing age and this was most evident above six years.

There was a significantly greater incidence of conductive hearing impairment (significant air-bone gap) and aural pathology in cleft palate children than in non-cleft palate children.

Approximately 50 percent of the cleft palate children whose otoscopic findings were positive showed unilateral abnormalities.

**SUBVERSIVE SUBMUCOUS CLEFT PALATE**

In 1971 La Vonne Bergstrom and William Hemenway of the University of Colorado Medical Center used otolaryngological and audiometric examination to evaluate 58 patients with submucous clefts of the palate. Recurrent or chronic disease of the middle ear in 39 percent ranged from serous otitis media to cholesteatoma. Thirty-four percent had conductive hearing loss, and 25 percent had either pure sensorineural or mixed hearing losses. Half of the patients with middle ear disease did not have speech disorders, and hence submucous cleft palate might not be suspected on that basis. Submucous cleft palate should suggest the possibility of accompanying, perhaps
asymptomatic, middle ear disease, and unresolving middle ear disease might be the reason to suspect SMCP.

ADVOCATES OF EARLY CLEFT CLOSURE

In 1972 Charles Bluestone, Jack Paradise, Quinter Beery and Ronald Wittel studied 22 infants with unoperated cleft palates who received myringotomies with tube insertions during the first three months and between the ages of 18 and 24 months had secondary palate closure with a V-Y pushback with or without an island flap. They evaluated Eustachian tube protective function by roentgenographic studies after instillation of radiopaque media into the nasopharynx and noted:

Infants with unrepaired palate clefts were conditionally able to clear radiopaque fluid media in a prograde direction from the Eustachian tube and middle ear into the nasopharynx, but there was obstruction to retrograde flow from the nasopharynx into the Eustachian tubes. Following surgical repair of the palate, there was improvement in prograde clearance and, in over half the ears tested, retrograde flow appeared normal.

Abnormal distensibility of the Eustachian tube in infants with cleft palate was suggested by the results of tests following repair of the cleft. This distensibility may be a function of reduced tubal stiffness (increased compliance) which may in turn contribute to functional obstruction of the tube by rendering its opening more difficult.

Their conclusion:

Prior to closure of the palate, middle ear fluid is present in all untreated infants. Since this seems to be related to functional obstruction of the Eustachian tube, ventilation of the non-aerated middle ear cavity is indicated. A previous study has shown that closure of the secondary palate is often followed by a reduction in the prevalence of middle ear disease. The present investigation confirms this finding and suggests a relationship to improvement in Eustachian tube function. It would, therefore, seem worthwhile to reconsider repairing the palatal defect at as early an age as possible, especially when otorrhea through a tympanostomy tube has failed to respond to medical treatment. Following repair of the palate, recurrence of middle ear effusion warrants repetition of myringotomy and insertion of tympanostomy tubes. However, if Eustachian tube function is improved following palate repair, or if otorrhea develops through the tympanostomy tubes, their removal on a trial basis may be indicated.
In 1973 Paulsen of Denmark reported:

Ear disease seems a little easier to control in patients with incomplete than with complete palate clefts, and a striking finding in patients with all types of clefts has been the improvement in overall otologic status following palate repair.

In 1975 E. R. Soudijn and A. J. C. Huffstadt of the State University Hospital, Groningen, studied 132 standard cleft palate patients before and after palate surgery. They found "glue" in the ears of 94 percent of the presurgical cases and reported:

Six months after the closing of the soft palate, the percentage of glue ears appeared to have already been reduced to 65. There is of course a tendency for decrease of aural pathology with advancing years, but this does not occur until the age of four, according to Graham. In our patients the highest age was only 19 months.

The most interesting aspect of our study however is the relatively high percentage (30%) of glue ears in children with cleft lips and in children of the control group. . . In babies with a cleft palate the pharyngeal mechanism appears to be so severely disturbed, that in 94% of the cases glue cannot be drained from the aural cavity.

They concluded:

Probably all children's middle ears contain glue at birth. In the cleft palate babies glue is present in 94%.

Inspection of the eardrums, eventually followed by myringotomy in cleft palate babies is indicated periodically.

Closing of cleft palate by surgery leads to improvement of tubal function.

In 1974 Margareta Korsan-Bengtsen and Olle Nylén of Göteborg, Sweden, studied the ears and hearing of 60 children aged 8 to 15 years who had had a Wardill-Kilner palate closure at 16 to 20 months and, if the cleft was complete, had had a Johanson-Ohlsson bone grafting at 8 to 10 months. Hearing and middle ear function was normal in 33 out of the 60. Screening audiometry revealed the incidence of conductive hearing loss exceeding 20 decibels at two or more frequencies to be 3 to 5 percent. The corresponding percentage of operated cleft palate children was 20 percent. This figure was considered very favorable since 75 percent of these children had serious middle ear disease before surgical closure of the palate. They concluded:
It would thus seem justified to recommend early palate closure, even from an otological point of view, in order to prevent tubal dysfunction with middle ear changes and hearing loss.

In 1977 Lee Dellon wrote:

In 1969 the first patient we corrected the levator of told me when he awoke that he could hear better. Post-op audiograms demonstrated correction of his conductive hearing loss. All we had done was alter his levator's insertion. I believe long-term follow-up will show that if levator retrodisplacement is included in the primary palatal repair, not only will speech results be improved but also hearing loss diminished, and I have written this limerick to emphasize it.

Medical art student Susan Seif and Dellon have written a 1977 study of "Interrelationships of the Levator and Tensor Veli Palatini Muscles and the Eustachian Tube: An Anatomic Reconstruction from Serially Sectioned Fetal Heads." It discounts the tensor as a tube opener but acknowledges the part played by the levator:

Indeed during isometric contractions the TVP increased girth will exert a pressure radially inward against the paratubal tissue. . . . The levator veli palatini muscle (LVP), as it goes from lateral and inferior to the medial plate of the Eustachian tube cartilage medially into the mobile soft palate, is in a unique position to elevate the medial tube cartilage. An isotonic LVP contraction elevates the soft palate posteriorly and the tubal cartilage medially. During this LVP muscle contraction the paratubal tissue would be compressed radially inward from below, while the radially inward "closing" pressure exerted by the "resting" medial cartilage would be relieved. . . . The incidence of hearing loss diminishes with increasing age because . . . with growth and development the LVP origin moves laterally (increasing its effectiveness in releasing the pressure of the medial cartilage plate on the tubal lumen) and the insertion moves downward and forward (increasing velar excursion and, again, increasing LVP effectiveness as a tubal "opener."

**NOT ALL CLEFT CLOSURES CURE**

In 1962 D. C. Spriestersbach, Dean Lierle, Kenneth Moll and William Prather of the State University of Iowa studied hearing in 163 cleft lip and palate patients and found the incidence of loss and magnitude of threshold deviations significantly greater in the
youngest age groups (33 to 77 months) than in any of the older groups. They noted no significant correlation between physical management (type or time of surgery) and hearing loss.

Unfortunately, closure of the cleft in the palate, although usually of benefit, does not invariably cure the ear problem. This failure has been blamed by some on certain aspects of the surgery, such as hamular fracture, tensor tendon division or other traumatic and scarring procedures responsible for preventing the development of normal tubal function. A 1920 study by A. R. Rich of Johns Hopkins University utilized a palatal incision to allow visualization of the tubal orifices. Rich found these orifices to be closed normally at rest but opened during the swallowing, yawning and sneezing reflexes.

The levator palatini, the palatopharyngeus, the internal pterygoid and the superior constrictor muscles of the pharynx, when either cut or stimulated, were found to exert no influence whatever upon the patency of the orifice or lumen of the tube.

The tensor palatini was the only muscle functionally related to the Eustachian tube. Contraction of this muscle was always accompanied by a dilatation of the tubal orifice and lumen. Relaxation or division of the tensor palatini was followed by a passive return of the tubal walls to the condition of approximation which they normally occupy when at rest. This work, of course, eventually pointed an accusing finger at fracture of the hamulus or division of the tensor tendon during cleft palate surgery.

**HAMULAR FRACTURE**

Fracture of the pterygoid hamulus during cleft palate closure has been blamed for perpetuating hearing impairment. Newmann in 1968, Graves and Edwards in 1944, and McMyn in 1940 all demonstrated that in addition to the main tensor veli palatini, which hooks around the hamulus to insert into the soft palate, a smaller component of this muscle arises from the Eustachian tube cartilage and inserts into the hamulus and the end of the hard palate. Skolnik in 1958 and M. A. Ross in 1971 confirmed that hamular fracture is related to occurrence of otitis media. Politzer,
as early as 1862, pointed out that the muscular relations of the Eustachian tube of the dog correspond closely to those of man. In 1962 Holborow’s experiment in dogs concluded that “the integrity of the tensor is essential for tubal opening,” and in 1971 Odoi, Proud and Toledo, after unilaterally “expunging” the hamulus in dogs, reported development of middle ear effusions.

Yet modern human studies raise much doubt as to whether hamular fracture affects ear physiology. In 1968 M. Bennett, R. H. Ward and C. A. Tait found no such increase after tensor tendon division. In 1972 Bluestone, Paradise, Beery and Wittel, following unilateral hamular osteotomy and infracture on 12 patients, noted:

No difference in Eustachian tube function was observed as a result of this procedure, and although follow-up has been short, recurrences of middle ear effusion have also appeared unrelated.

In 1973 in the *Cleft Palate Journal* Barrett Noone, Peter Randall, Sylvan Stool, Ralph Hamilton and Richard Winchester of the University of Pennsylvania presented a sketch of their rendition of tube, tensor and hamulus anatomy. They then reviewed a randomized series of 89 patients undergoing soft palate closure between 1963 and 1969 in which unilateral hamular fracture was alternated between the right and left sides. They reported:

An evaluation of the development of clinical middle ear disease and documented hearing loss by audiogram during a three-year postoperative fol-
low-up period demonstrated no difference between the ear on the side of hamulotomy compared to the opposite ear.

OTHER SURGICAL TRAUMA

In 1966 Otto Kriens of Bremen, while studying the anatomy of palatal musculature in Prague, concluded that the levator muscle elevated the medial edge of the tubal cartilage and additional opening was effected by the pull of the tensor muscle. In the cleft palate, the pull of the tensor muscle was in deviated craniolateral motion which did not elevate the medial edge of the Eustachian tube. Kriens warned against surgical intervention near the epipharyngeal portion of the tube. He felt that fracture of the hamulus might disrupt the musculotendinous apparatus near the tube, and, even worse, dissecting and packing the space of Ernst could disrupt the equilibrium of the muscles in this area, to be further compounded by resultant scarring.

EFFECT OF PHARYNGEAL FLAP ON HEARING

Evidently pharyngeal flaps do not affect hearing. M. D. Graham and D. Lierle found in 1962 that the pharyngeal flap procedure did not aggravate an existing hearing loss. In 1966 G. Aschan concluded that surgical reconstruction by velopharyngoplasty helps to restore tubal functioning and thus hearing. G. W. Leworthy and H. Schliesser reported in 1975:

The application of a pharyngeal flap did not decrease the preoperative hearing acuity in 96 per cent of our 53 patients.

T & A

To remove or not to remove the tonsils and adenoids, that is a question even in the normal child. Recurrent nasal discharge, repeated attacks of otitis media and respiratory obstruction are accepted as criteria for a T & A. In 1965 N. J. Chalat noted improvement in hearing in 75 percent of cleft palate patients after tonsillectomy and adenoidectomy.
Yet in the non-cleft child or in the unrecognized submucous cleft case, removal of the adenoids can result and has resulted in the disastrous production of hypernasal speech. In the cleft palate child the need for any extra prominence in the posterior pharyngeal area to aid in velopharyngeal closure causes hesitation in the random removal of the adenoids. Some surgeons are enthusiastic about partial adenoidectomy in the treatment of otitis media, preserving speech by removing only the lateral portion of the adenoid under direct vision. This maneuver, however, is not so easy. As suggested by Stool, it may be possible to preserve the child's adenoid tissue if the ear disease is treated via the tympanic route first.

The removal of the tonsils is slightly less hazardous, provided the surgeon shells out the tonsil carefully, preserving the anterior and especially the posterior pillars and avoiding excessive postoperative scarring.

**POSSIBLE ANATOMICAL CAUSES OF INADEQUATE TUBE FUNCTION**

According to Wilma Maue-Dickson of the University of Miami, there is no indication that the extrapalatal anatomy of the tensor veli palatini muscle is abnormal in cleft palate. Even in severe cleft of the palate the presence of a well-defined palatal aponeurosis (the tendon of tensor) can be demonstrated in the palatal tags in histological sections. In 1975 an anatomical study by Maue-Dickson showed that human fetuses with cleft palate consistently have (1) narrower and smaller auditory tube lumina which are more widely separated than in normals, (2) greatly enlarged auditory tube cartilages, also more widely separated than in normals, (3) more widely separated pterygoid plates than in normals, and (4) significantly reduced pharyngeal height but greatly increased pharyngeal width—all of which were shown in cross section in Chapter 2. One conclusion from these data is that the space between the lateral pharyngeal wall and the side wall of the cranium is substantially reduced and that the tube may suffer a mechanical disadvantage as a result. The problem may be reduced by craniofacial growth, which sometimes relieves stress.
on the tube. This suggestion is consistent with the observation that children with cleft palate typically have reduced middle ear problems within the first few years of life.

**PATHOGENESIS**

It is the responsibility of the Eustachian tube to ensure that the external and the middle ear air pressures remain the same. Anything that interferes with evacuation of embryonic tissue from the middle ear and subsequent pneumatization of the temporal bone, or with the function of the Eustachian tube to prevent it from supplying the middle ear with air, will result in conductive hearing loss.

There are several clinical stages in the pathogenesis of ear disease, as noted by Stool. The *exudative stage* has acute, subacute and chronic phases.

The *viscid stage* results from failure of resolution of the exudative stage. The middle ear is filled with thick, tenacious mucoid substance. The audiogram usually reveals an average loss of 3 decibels due to failure of movement of the tympanic membrane. Treatment involves removal of the viscid material from the middle ear via a myringotomy and substitution of a prosthesis for the function of the Eustachian tube.

In the *adhesive stage* the tympanic membrane is adherent to the structure of the middle ear. It is usually seen in later childhood when the previous stage was not resolved. The membrane becomes atrophic and flaccid and collapses against the medial wall of the middle ear with a loss of 40 to 60 decibels. Desquamated epithelium gets caught and collected in the adhesive pockets of the tympanic membrane. Treatment includes myringotomy, aspiration of fluid and insertion of tubes coupled with eversion of invaginated pockets. The replacement of atrophic membrane with grafts may be of value. The best treatment for this stage is prevention.

The most serious complication is the formation of a cholesteatoma. In the cleft palate this is acquired during the adhesive stage when invaginated pockets collect squamous debris. Diagnosis may depend on x-ray demonstration of a radiolucent area.
Removal of the abnormal tissue is mandatory for cures and to prevent extension into surrounding structures including the brain.

In 1975 Jack Paradise took an international view of middle ear problems associated with cleft palate, stating:

Eighty years have elapsed since Gutzmann in Germany first observed that approximately half of all patients with cleft palate suffer from significant reduction in auditory acuity... The mucous membrane lining becomes markedly thickened, the epithelial cells undergo metaplasia, and there is a great increase in the secretion of mucus.

Noting that even children with normal palates commonly experience secretory otitis media, he listed a string of international investigators studying the histological and biochemical abnormalities that characterize this sterile inflammatory process in the middle ear. Sade (Israel), Senturia (U.S.A.), Paparella (U.S.A.), Lupovich (U.S.A.), Gunderson and Gluck (Norway) and Mogi (Japan) have all contributed to a better understanding of the middle ear changes.

PULLEN

Fred Pullen of the University of Miami School of Medicine, while training at the Massachusetts Eye and Ear Infirmary in Boston, became infatuated with otology under Harold Schuknecht. Pullen's nasal fracture during a Michigan Golden Gloves tournament, a skilled light touch and his center-of-the-target attack on clinical problems made him the perfect otolaryngology member of our Cleft Palate Team. Here is his 1977 stand:

The Eustachian tube connects the middle ear cavity to the nasopharynx. In the adult, the anterior two-thirds is cartilaginous and the posterior third bony, but in the infant the bony portion is relatively longer. The direction of the tube in the adult inclines superiority with the horizontal plane at an angle of 30° to 40°, but in the infant this inclination is only 10°. The lumen of the Eustachian tube is shaped like two cones with the apex of each directed toward the middle. The aural orifice of the tube is oval in shape, measuring 5 mm high and 2 mm wide in the adult. The nasopharyngeal orifice in the adult is a vertical slit at right angles to the base of the skull, but in the infant this opening is oblique due to the more horizontal position.
of the cartilage. The diameter of the orifice is 8 to 9 mm in the adult and 4 to 5 in the infant. In the newborn, the nasopharyngeal orifice lies in the plane of the hard palate, but in the adult it is situated 10 mm above this plane. The middle portion of the Eustachian tube, or isthmus, is not sharply constricted, but is relatively long, with gradual widening at each end, forming the aural and nasopharyngeal orifices. The diameter of the isthmus in the adult is 1 to 2 mm; but in the infant it is somewhat larger. The mucosal lining of the cartilaginous portion is similar to that of the nasopharynx and contains mucous glands. The mucosa in the protympanic portion of the Eustachian tube is similar to that of the middle ear and contains both mucus producing elements and cilia. The function of the Eustachian tube appears to be two-fold: clearance of secretions and ventilation of the middle ear.

Usually the Eustachian tube is closed, but it opens during swallowing, yawning and sneezing, permitting the air pressure in the middle ear to equalize with atmospheric pressure. This opening mechanism is muscular and involves the nasopharyngeal orifice. The tensor palati is the only muscle related to tubal function, and closure is the result of relaxation of the tensor palati with passive approximation of the tubal walls.

The tensor tympani muscle originates from the cartilaginous portion of the Eustachian tube and the adjoining part of the greater wing of the sphenoid, as well as from the bony canal in which it is contained. It passes backward through the canal, enters the middle ear as a slender tendon which bends laterally around the processus cochleariformis and is inserted into the neck of the malleus and into the tympanic membrane directly.

In 1970, A. J. Lupin demonstrated by dissections that the tensor palati and tensor tympani muscles have fibers that intermingle. Both of these muscles have fibers originating in the area of the greater wing of the sphenoid near the spine, and also both have fibers originating from the Eustachian tube. There is intermingling of these fibers on the undersurface
of the sphenoid spine. The common development of these muscles is from the mandibular arch with a common nerve supply from the mandibular division of the trigeminal nerve. There are three branches to the three divisions of the tensor palati muscle and one to the tensor tympani. These two muscles are, in fact, continuous and, indeed, the tensor tympani muscle is a continuation of the muscle fibers from the anterior portion of the tensor palati with additional slips from the base of the sphenoid bone and from the periosteum lining its semi-canal. The contraction of the medial part of the tensor palati muscle unrolls the tubal cartilage by depressing the lateral lamina, thus opening the nasopharyngeal orifice of the tube.

It is postulated here that the contraction of the tensor palatini is accompanied by a similar contraction of the tensor tympani muscle, thereby exerting a slight medial or inward movement of the tympanic membrane. This combined movement thereby acts as a "pump" mechanism to help clear the air or "push" secretions out of the Eustachian tube into the nasopharynx. Tympanometry measurements of the ear were performed at −150 mm of water pressure thereby causing the tympanic membrane to be pulled laterally into the external auditory canal. Upon voluntary contraction of the tensor palati and tympani muscles, the pressure in the outer ear canal increased by 3 to 5 mm, proving a medial motion of the tympanic membrane thereby substantiating this "pump" mechanism. The function of the tensor tympani muscle is therefore to provide 3 to 5 mm of positive pressure in the middle ear and Eustachian tube upon the opening of the Eustachian tube by the tensor palati. This pressure need not be more than that when one realizes the minute movements of the tympanic membrane which produce hearing. Air is thereby forced out of the Eustachian tube upon swallowing and new air then rushes into the tube and middle ear, providing a continuous cycle of high oxygen containing air in the middle ear. The function of the tensor tympani muscle has always been a mystery. Clearly now the function and importance of this muscle has become elucidated.

In patients with cleft palate there is no opposing action of the opposing tensor muscles, the Eustachian tubes remain closed and the pump mechanism does not function. If the Eustachian tube fails to open, the middle ear cannot be adequately aerated and fluid usually accumulates in it.

Identification of Serous Otitis Media

Pneumatic otoscopy as noted by J. Northern in 1976 is the accepted final criterion and absolute reference in the evaluation of ear disease. However, physicians vary tremendously in ability to interpret their observations during otoscopy and pneumotoscopy. A case history can be unreliable, and hearing tests conducted during infancy are rather complicated. Consequently, an early recognition of any disturbances in early childhood mainly depends upon an improved diagnosis, with the aid of a microscope.
In regard to audiology, traditional hearing tests are not sufficient to identify otitis media, and changes in hearing sensitivity do not necessarily relate to changes in the otologic disease process. Fifty percent of 408 ears with serous otitis media would have passed as "normal" on school hearing tests conducted at the accepted screening level of 25 dB HL.

**Acoustic Impedance Measurements**

The most sensitive screening technique for identification of serous otitis media is tympanometry. Tympanometry is defined as an objective technique for measuring the compliance (or mobility) of the tympanic membrane while varying air pressure in the external auditory canal. Tympanic membrane mobility is of particular importance since almost any pathological condition located on, or medial to, the eardrum will influence its movement. Tympanometry, compared to otoscopy, is totally objective, and eardrums noted to have normal mobility by pneumatic otoscopy examination can be shown to have abnormal mobility with tympanometry. Acoustic impedance contributes especially meaningful information about middle ear disease in cleft palate children and should be a routine part of their evaluation. In 1975, F. Bess, H. Lewis and D. Cieliczka noted that in cleft palate children identification of middle ear problems is possible with impedance when the audiometric and otologic examinations were normal.

**Management of Otologic Problems**

The treatment of infants with cleft palates must be directed toward the correction of effects as well as causes. Before repair of the secondary palate, elimination of middle ear fluid and aeration of the middle ear are the responsibility of the otologist and can be accomplished by myringotomy, aspiration and insertion of tympanostomy or pressure equalization tubes. The insertion is usually made in the anterior superior or inferior quadrant. The middle ear is then aspirated with a suction tube and the PE tube inserted.

This procedure should probably be performed soon after birth and close follow-up is necessary at least every two months. When spontaneous extrusion of tubes occurs, repeat myringotomy and reinsertion should be carried out. During the first year of life, these infants ordinarily have one or more reconstructive procedures on the lip or primary palate requiring general anesthesia. This provides an excellent opportunity for re-evaluation of the tympanic membranes, by means of the operating microscope, and for reinsertion of tympanostomy tubes if necessary. Infants should probably sleep in the prone position; when awake and supine, it may be helpful for the head and neck to be kept elevated at least 20° above the horizonal.

The tympanostomy pressure equalization tubes should be reinserted as many times as necessary until adequate functioning of the Eustachian tube is
demonstrated by a well-pneumatized middle ear upon repeated examinations. Occasional autoinflation of the middle ear may be performed to maintain the pneumatized middle ear. It is only continuous and meticulous attention to the aeration of the middle ear which will prevent serious and permanent otologic disability, and as long as air is there, I am not concerned about early closure of the palate.

THE PULLEN PLUG

Fred Pullen has devised a plug to allow children wearing tubes to swim, and in Florida swimming is important. He noted in 1978:

A high molecular weight polymer plastic cork (Richards Manufacturing Company, Memphis) which allows air but not liquids to pass in, is inserted into the P.E. tube. These little patients can then go swimming without fear of otitis media from getting water in the middle ears. This plug has been used for two years in over 200 cases with only one infection.
Thus, it can be said that cleft palate infants have an extremely high incidence of fluid in the middle ear, and whether this is due to the cleft in the normal tensor mechanism, abnormal tube anatomy or the relatively restrictive and compromising craniofacial relations, certain points become clear:

1. If fluid in the middle ear is ignored, hearing loss is increased, especially in low frequencies with inability to hear hypernasality. (Deaf children often speak with hypernasality.) The hypernasal cleft palate speech, not being detectable to the patient, reduces his chances of correction, even after surgical production of a competent velopharyngeal sphincter, thus setting up a *vicious cycle* for the speech therapist.

2. Early examination under the microscope, myringotomy, suction of accumulated fluid and insertion of tubes are important.

3. Repeated examinations under the microscope during the cleft surgery and reinsertion of tubes when necessary are essential.

4. As long as aeration of the middle ear is maintained, there is no hurry for palate surgery as far as hearing is concerned.

5. Craniofacial growth is probably responsible for improved tubal function, and therefore time is an ally if aeration is maintained.

6. It is possible that freeing, uniting and retrodisplacing the levator is the part of the surgery that benefits the Eustachian tube function.
6. Anesthesia in Clefts
(Gas, Tubes and Gags)
WITH SECTIONS BY S. MACMAHON AND A. FREEMAN

ANESTHESIA IN CLEFT LIP

In ancient times cleft lip was treated by pinning of the pared edges, which never took more than a minute or two. When dentist William Thomas Green Morton introduced general anesthesia in 1846 at the Massachusetts General Hospital, Boston, it was soon used for these quick lip closures. John Snow reported giving ether for a lip repair in 1847 and by the time of his death in 1858 had administered chloroform 147 times for this operation, mainly for Mr. Fergusson of King's College Hospital. Most of the patients were infants between 3 and 6 weeks old. The infants had rested in Mr. Fergusson's lap, and according to anesthetist Snow:

In a few cases of strong children, in whom the bleeding is rather free, the breathing gets embarrassed, and Mr. Fergusson turns the face of the child downwards for a moment to let the blood run out of its mouth. . . . The effects of chloroform pass off very quickly in infants, and it is not often that they last till the operation of harelip is finished, short as that operation is.

Within a year of its presentation in Boston, ether anesthesia was used by Dieffenbach, in the fall of 1847. His stamp of approval had been awaited by the continent of Europe. Over the next 100 years anesthesia for cleft lip surgery progressed fantastically. The highlights were the change to ether, Magill's intubation, Ayre's T tube and Dott's mouth gag. Since all these devel-
opments had become well established by 1950, it was a shock to me at that time, returning from England, to find Claire Straith of Detroit operating without endotracheal anesthesia and thus resorting to mild sedation and local anesthesia. Such conditions were not conducive to careful design and meticulous execution of a lip closure. Yet there were times in Korea when my experience with Straith was put to good use in clefts. Fortunately this course is no longer necessary.

ANESTHESIA IN CLEFT PALATE

The cleft in the palate being less accessible, its surgery came later. Even then, the early palate surgeons—Monnier, von Graefe, Roux and Dieffenbach—did not have the advantages of general anesthesia. Von Langenbeck used ice to produce local numbing of the palate.

Gordon Jones of the University Hospital of South Manchester, England, in his excellent 1971 history of anesthesia for harelip and cleft palate, noted early isolated attempts with general anesthesia. The first report of a case that he could find appeared in the \textit{Lancet} of 1850, stating that Mr. Gay, of the Royal Free Hospital, used chloroform in closing a bilateral cleft lip and hard palate in a 7-year-old boy.

The majority of surgeons, however, were against using general anesthesia for palate cases. In 1862 Fergusson of King’s College Hospital, who was quite happy with general anesthesia for lip clefts, declared that repair of the soft palate was one of the few operations in which chloroform could not be used. Sansom, an associate of Fergusson, wrote in 1866:

In cases of operation for cleft palate and such manipulations as require co-operation on the part of the patient, chloroform should be dispensed with or else given very sparingly. A few whiffs may be permitted so that the local sensibility may be benumbed. A gargle of iced water is the best local anaesthetic during the intervals of the operation.

John Snow was meeting the same opposition from other surgeons:
I assisted the late Mr. Avery by giving chloroform in two operations for cleft palate. . . . The surgeon, however, much prefers to have the patient awake during this operation, when he can get his assent.

Even in America and at the Massachusetts General Hospital, J. Mason Warren, a friend of Morton's, affirmed that repair of cleft palate

is one of the very few operations in which the use of anaesthetics is inadmissible. Under very peculiar circumstances, I suppose, ether might be administered, but not without some risk to the patient, and much embarrassment to the surgeon, from the constant flow of blood down the throat. . . . It is necessary to wait until the patient is old enough to fully appreciate the importance of the operation and to submit patiently to pain and inconvenience.

This fearful attitude was changed during the 1860's through the work of M. H. Collis at the Meath Hospital, Dublin, and Sir Thomas Smith of St. Bartholomew's Hospital and the Hospital for Sick Children in London. Their heated controversy in competition for priority probably speeded the acceptance of anesthesia.

In 1868 Smith presented a paper to the Royal Medical and Surgical Society which was reported by a correspondent of the *British Medical Journal*:

The author's object in presenting this paper was to communicate to the Society a plan of operating on clefts of the palate, applicable to all who suffer from the deformity, but especially to children. . . . The chief novelty in this proceeding was that chloroform could be employed. A painless and speedy operation could therefore be performed, and that with more precision and a greater prospect of success. . . . while from the painless nature of the operation, the cure of cleft palate could be effected in children, to whom formerly the benefits of staphylorrhaphy were virtually denied.

In the same month a letter was published in the *British Medical Journal* from Collis:

Sir,—let me call the attention of Mr. Thomas Smith to the *Dublin Quarterly Journal*, vol. XLIV, p. 345, by which he will see he is anticipated in this improvement. . . . I have used it (chloroform) in all my palate operations for two years and a half. . . . I believe, I was the first to operate with success on young children, and the first to use chloroform.
This suggested that Collis first used chloroform in cleft palate surgery in 1865 and, in support of his claim of having preceded Smith, the Dublin Quarterly Journal of Medical Science editor wrote in 1867:

It is now fully established that chloroform can be given in these cases. Mr Collis gives it habitually and has been thus able to operate with success on very young children. The danger from chloroform is no greater than in any other operation and the relief from pain and from subsequent shock and depression is of the greatest importance. Of the advantages of early operation as regards the patient’s education, it is needless to speak.

In 1912 J. Berry and T. P. Legg recorded the difficulties being experienced at that time:

The anaesthesia should be deep enough to abolish sensation, but not to do away with cough reflex. . . . The most suitable anaesthetic is undoubtedly chloroform. . . . We have sometimes employed ether for induction, but the tendency to the secretion of mucus and saliva, as well as the increased venous congestion caused by the ether . . . is apt to be troublesome. . . . [Chloroform] should be given through a Junker’s tube inserted either into one nostril or preferably at one corner of the mouth. . . . An experienced anaesthetist will often be able to lend a hand with the sponging, and . . . if the bleeding be unusually free, . . . or if vomiting occur, . . . it may be advisable to suspend the operation for a short time while the child is turned on its side.

Berry and Legg concluded, and with feeling:

The difference to the surgeon, between doing a cleft palate operation with a thoroughly experienced anaesthetist and an inexperienced one, is the difference between pleasure and pain!

**PATIENT’S POSITION**

By 1874 Edmund Rose of Zurich was presenting a new position for the patient during the administration of general anesthesia while operating in the mouth. Rose placed the patient on the back on the operating table with the head hanging over one end while the foot end of the table was raised about 12 inches above the horizontal position. Thus blood collected in the nasopharynx could be sponged and, in later times, suctioned out instead of allowed to run down into the larynx and esophagus. This position became popular and was still being used and taught when I
interned with Ladd, Gross, and MacCollum at Harvard in 1944. In fact, Dr. Ladd sat down and operated with the baby’s head in his lap, as did Blair, Veau, Kilner and Wardill, among others.

EXPOSURE

Meanwhile, mouth gags were being designed to improve exposure and later were to assist the anesthetist. Gags by Lane, Rose, French and Doyen-Jensen simply held the mouth widely open, requiring a tongue stitch to maintain an airway and a view for the surgeon.

Thomas Smith’s 1868 gag incorporated a tongue depressor, as did gags designed by Whitehead, Collin, Geffer and Mahu. Berry and Legg warned of the dangers of obstructing the airway with the tongue depressor.
Some of the gags began to get more complicated and, incidentally, to look more like the gags of today. Trélat’s, Lexer’s modification of the Whitehead gag and the fantastic appliance of Edoardo Bassini are shown:

Then, to assist the anesthetist, both Mason and Doyen equipped their gags with thin metal tubes fixed to the gag blades through which the anesthetic vapors could be insufflated into the oropharynx.

**Dott**

Norman W. Dott of Edinburgh started out as an engineer but, convalescing from a motorcycle accident in which he suffered bilateral tibial fractures, became intrigued with medicine. He took his medical degree and for a time was involved in pediatric surgery before he became the first professor of neurosurgery at the University of Edinburgh. During his pediatric experience he did cleft palate surgery and turned his knowledge of engineering toward the construction of a mouth gag that forms the basis of all gags popular today. It was C shaped, with one side open, and incorporated a tongue depressor.

**Kilner**

One version of the Dott gag incorporated an anesthetic tube in the tongue depressor. Kilner added a spring coil around the top to hold sutures in perfect order prior to tying, in keeping with his tidy surgery.
In 1962 Dingman and Grabb reported on a modification of the Dott-Kilner gag as a closed rectangular frame with bilateral alveolar retractors and a tongue blade sliding through a ratchet. The tongue blade supported the gag inferiorly and held an endotracheal tube over the tongue. To this had been added bilateral side retractors which hooked the lips near the commissures to pull the cheeks laterally out of the way. At about the time of this gag’s introduction, Reed Dingman, accompanying me on a Caribbean work trip, asked:

What is happiness?

and when none of us came up with the appropriate answer, he continued:

This mouth gag for a surgeon operating on a cleft palate!

He then presented us with one of his brand-new gags, and it has been standard equipment for cleft palate cases at the University of Miami School of Medicine ever since.

Over the years I have experienced a couple of difficulties with this gag, the major problem being the lack of adaptability of the rigid rectangle to fit the irregular alveolae.

**Miami modification**

The majority of severe cleft palate patients have abnormal spacing between the maxillary alveolar arches. When there is maxillary retrusion, collapse or a protruding premaxilla, it is difficult to fit both alveolar hook retractors on the irregular alveolae when these retractors are attached to a rigid rectangular frame. Once fitted, the purchase is often unstable because only one retractor can get good contact with an alveolus. The gag may slip midway through the operation. Then too, the frame does not allow the retractors to maneuver into an effective position in the presence of a severely projecting premaxilla. If it is forced on, it traumatizes the premaxilla, or at least the prolabium. Resident David Slepyan was challenged to try to improve the gag, and he in turn found Jack Nestor, an ingenious machinist and sculptor, who used the Dott-Dingman tongue depressor and ratchet arrangement with a
posterior bar to hold a pair of telescoping 360-degree rotating barrels. The anterior bar was divided to admit any projecting premaxilla. For more mobility the anterior segments were constructed to slide sideways through the lateral barrels, and these sliding anterior arms were capped with swivel-hook retractors which could be set at any angle to clasp the alveolae. The swivel-hook retractors were made interchangeable—one for infants, one for adults. The adult hook has a beveled radius to present a wedge which fits between the teeth to prevent slippage. A lock-stop screw controls outward rotation of the swivel-hook retractor. This completed the total adaptability the gag to near-ecstatic proportions for any irregularity of the alveolar arch in patients of any age.

The Dingman side cheek retractors can be installed, yet in palate surgery it has been my experience that the amount of vertical mouth opening needed for velopharyngeal surgery will sometimes burn the commissures. Thus one fears that the additional lateral pull for transverse opening, which for palate surgery is unnecessary, may cause even greater stretch burns.

The Miami gag modification, published in *Plastic and Reconstructive Surgery* in April 1977, can be obtained from Jack Nestor, 148 N.E. 29th Street, Miami, Florida 33137, upon request or from Padgett Instruments, Kansas City, Missouri.

**ENDOTRACHEAL ANESTHESIA**

The most monumental advance in cleft lip and palate anesthesia came with the introduction of endotracheal anesthesia. This was accomplished by a thin insufflation catheter passed by direct vision into the trachea. Ivan Magill first used the method on infants in 1921 and first intubated a cleft palate case for Harold Gillies at Great Ormond Street in 1924.
Sir Ivan Magill's story is fascinating. He was graduated from Queen's University Belfast, Ireland, and near the end of World War I arrived at the Plastic and Jaw Unit at Queen's Hospital, Sidcup. One look down the wards of bandaged broken jaws and wounded faces was warning enough that anesthesia here would be no picnic. At that time ether vapor was administered through a gum elastic catheter with the aid of an electrically driven pump to create a positive pressure to prevent blood from trickling into the trachea. The surgeon got the blast of the patient's ether-laden expirations and was often enveloped in a spray of blood. Constantly, Harold Gillies, half asleep from Magill's ether, would growl:

Maggie! You seem to get this ether in here jolly well. Why can’t you take it out again?!

Magill tried two tubes, then one wide-bore single rubber tube which he found could be passed blindly into the trachea through the nasal route when the head was in the position affording the freest nasal airway, as in "drinking a pint." In 1925 in Paris, at the first truly International Congress of Plastic Surgeons, Magill demonstrated his nasal intubation on a cadaver. Later, at the request of a French surgeon, he intubated a patient. The surgeon, accustomed to a porter with a bottle of chloroform crouched over a cyanotic, coughing, struggling patient, took one look at his patient lying quietly with Magill's tube in place and cried out that his patient was not breathing, then that he was dead! Whereupon Magill assured him all was well.

Evidently, French surgeons were not totally convinced. Visiting Paris in 1948 I watched Jacques Récamier do a Veau cleft palate procedure at l'Hôpital St. Michel. With some difficulty from behind a modified gas mask worn to prevent the chloroform from anesthetizing himself, Récamier was forced to pause constantly to allow the patient's cyanosis to pass.

Meanwhile, Magill continued to improve the technique of endotracheal anesthesia. He placed a battery in the handle of the laryngoscope to provide a light without wires and wall plugs, a slot in the laryngoscope barrel to accommodate tubes, mineral-
ized rubber tubes smoothly beveled at one end and in 12 sizes. He also designed wide-angled metal tube connectors for oral intubation and acute-angled connectors for nasal intubation, in order to keep the anesthetic apparatus fitted snugly to the profile and out of the way of the surgeon.

Magill found that in cleft lip and palate cases laryngeal edema was not necessarily a danger. The real difficulty was in developing a tube thin enough for an infant that would not collapse. Finally, in 1932 he turned to a metal coil covered with thin rubber cemented to a 3/4 inch piece of standard rubber endotracheal tube beveled at one end. The other end was attached to a Y metal connector to reduce rebreathing. This principle preceded Ayre's T tube. Such a flexible, unkinkable, armored tube could withstand the pressure of the tongue depressor in the Dott mouth gag without collapse and facilitated oral intubation with the tube out of the surgeon's field. The anesthetist could also relax as his tube was safely stabilized by the tongue depressor. A pharyngeal pack or a Magill inflatable cuff was used to prevent blood and secretions from slipping by the tube down the trachea. Once Magill had his intratracheal tube in position and the patient sleeping peacefully, he would get out some string, cork, tubing and a pocketknife to experiment in constructing gadgets for his anesthetic apparatus with much the same concentration he tied flies while trout fishing the Test River.

By 1936 Digby-Leigh and Fitzgerald of Montreal were using Magill's tubes, as was Ayre for Wardill in 1937 and Gillespie for Kilner at Elizabeth of York Hospital for Children at Shadwell in 1939.

Ayre

Red-haired Philip Ayre, anesthetist to Babies' Hospital, Newcastle upon Tyne, was a postoperative unilateral complete cleft of the lip and palate individual with only a reasonable repair himself. He found on cleft lip and palate cases that the Magill wide-bore rubber catheter through the mouth into the trachea worked satisfactorily except for the suboxygenation when nitrous oxide was being used in babies and the difficulty in adjusting the amount of rebreathing. No matter how small the rebreathing
bag, there was always too much "dead space". Because of anoxemia and excessive rebreathing, the condition of cleft babies showed marked deterioration within a short time. Ayre was in a state of desperation as he explained in 1937:

In an endeavour to remedy this distressing state of affairs (and spurred on by the caustic criticisms of a candid surgeon!), the writer sought to devise a method by which the endotracheal technique could still be utilized without the drawbacks associated with nitrous oxide and excessive rebreathing. . . .

Briefly, the apparatus consists of a T-piece which is connected by a short piece of rubber tubing and a Magill angle-piece to a wide-bore rubber catheter previously inserted into the trachea. Through one limb of the T-piece oxygen and ether vapour is delivered from a Boyle or other continuous-flow apparatus. The other limb remains open to the outside air; for convenience, a short piece of tubing may be attached and allowed to hang down beneath the operating towels. A strand of fine gauze, fixed with adhesive strapping close to the open end of the latter tubing, will wave to and fro with the patient's respirations, thus serving as a useful indicator to the anaesthetist. . . . The excellent colour and quiet, natural breathing of the babies have convinced us that oxygen and ether vapour, administered by the T-piece method, is the anaesthetic of choice for all hare-lip and cleft palate operations on babies and young children. . . . The post-operative convalescence is remarkably smooth and free from anxiety. Last, but by no means least, comparative peace now reigns in an operating theatre formerly the scene of many sanguinary battles!

A final point of finesse came when in 1954 R. M. Davis modified the Dott tongue depressor with a slot to accommodate the Magill tube.

As Gillies was doing very few primary cleft lip and palate operations, I took the opportunity to visit Wardill in Newcastle and there observed Ayre using his happy T tube. Once a fortnight, at Lord Mayor Treloar Children's Hospital, Alton, I had a chance to observe Kilner and Peet operating on lips and palates. Their anesthetist was John Hunter, who at 240 pounds was the Friar Tuck of anesthesia. It was fascinating to see huge and jovial John turn an infant fuzzy with N₂O, taking it down with Vinethene followed by ether drip prior to intubation under direct vision. He carried the babies through the operation on pure gas-oxygen-ether with the Ayre open T tube. His anesthesia was smooth, the baby almost never turning blue or coughing blood
in the surgeon’s face. The operation by Kilner or Peet was so
organized that Hunter could intubate, leave the room, return in
one hour by the clock and, without even looking or asking, it
seemed, pull his tube. By 1949 he had anesthetized over 2,000
infants without a mortality.

During the last 20 years the use of controlled intermittent
positive pressure respiration, with or without the use of muscle
relaxants, has become popular for pediatric cases. Anesthetic
agents in cleft surgery have changed from chloroform to ether
and now to halothane. Wallbank has shown that in infants and
children up to 2 years of age the doses of epinephrine required to
aid hemostasis may be safely used in the presence of small
conzentations of halothane.

FINDING THE VEIN FOR I.V.

In 1977 Robert Woolf of Salt Lake City suggested an aid to
anesthetists attempting to place a needle in infants for adminis­
tration of intravenous fluids during surgery. If a fiberoptic light is
placed under the hand, the arcade of vessels, not easily visualized
through the skin in fat babies, will be vividly presented.

MIAMI ANESTHETISTS

It has been my good fortune to have two excellent anesthetists
for the cleft babies. Their thoughts and tricks are important.

MacMahon

F. Stan MacMahon received his medical degree at University
College, Dublin, Ireland, trained at the Anesthesiology Center,
Copenhagen, and then became a journeyman anesthetist around
the world, ending up in the Bahamas. For many years he gave
superb anesthesia for the cleft babies I operated on at Princess
Margaret Hospital, Nassau. Imagine my elation when he decided
to come to Miami and became Clinical Director of Anesthesia at
the University of Miami School of Medicine, Jackson Memorial
Hospital. Here is his contribution:
Ralph Millard and I have been operating together on patients with these problems for over sixteen years. Early in the series I learned that the virtuosity involved in the functional and cosmetic repair of these babies requires the anaesthetist to apply the art as well as the science of his profession. The surgeon demands a clear, uninterrupted operating field with normal, uncontroverted anatomy; the anaesthetist must have control of the airway at all times. For both parties on either side of the ether screen to perform smoothly, such a mutual understanding is essential. Compromise is the essence of diplomacy, and, after a few initial skirmishes, Ralph and I signed a "Mutual Aid Pact" and have since worked in perfect harmony.

In attempting to describe the anaesthetic technique which we have evolved over the years, I am reminded of the Ninth Century Irish monk who, in a moment of anguish, wrote on the margin of his scholarly text:

Meisse ocus Pangur Bán,
cechtar nathar fria shaindán;
bíth a menma-sam fri seilg
mo menma cén im shaincheird.*

At least Gallarus had his cat for company and inspiration. . . .

Simplicity usually means safety. For this reason, a modified Jackson Rees system, delivering nitrous oxide, oxygen and halothane on spontaneous respiration and incorporating an artificial sigh, is utilised. During the mask induction it is important to recognise that airway management may prove difficult. The most common cause of obstruction (which, at times, may be complete) is what I refer to as "corking" of the palate by the tongue. When the cause is known, however, the remedy is indeed simple.

When the patient has reached a surgical plane of anaesthesia, laryngoscopy is performed. To avoid even mild trauma to the epiglottis, the author prefers to use an infant Mackintosh laryngoscope blade at first and, in 90% of cases, can obtain a clear view of the larynx. If a clear view cannot be obtained with this blade, then one progresses through the Roberts-Shaw, the Sheila Anderson and the Miller blades until a clear view is obtained. Personally, I never attempt to intubate these children unless I can see the larynx clearly. My reason for this is that I look on these cases as elective, and at no time should the child be jeopardized by injudicious attempts at intubation. Cole tubes cut to the appropriate length, with a Magill type catheter connector, are used. It is essential that the Magill connector lie flush with the chin.

*For the non-Gaelic speaking:

I and Pangur Bán my cat,
'Tis a like task we are at:
Hunting mice is his delight,
Hunting words I sit all night.
thus providing an uninterrupted operating field. To achieve this, tubes of
varying sizes and lengths should be at hand.

The introduction of the corrugated tubing between the Inglis valve and
the Magill connector is a compromise reached between the anaesthetist and
the surgeon. From the anaesthetic point of view, a measured "dead space" of
7 cc's is added to the system, but the flexibility achieved is of great value to
the surgeon.

For cleft lip adhesion or closure, a solitary piece of plastic tape placed low
don the chin, combined with a pharyngeal pack, suffices to keep the
endotracheal tube in situ. In cleft palate closure, the blade of the mouth gag
serves the same purpose admirably.

Pulse, respiration, blood pressure, temperature and EKG are monitored at
times. Maintenance I.V. fluids are given. Hypothermia is avoided by the
use of a warming blanket. Accurate measurements of blood loss are made by
weight and calibrated catchment trap in the suction line. It is seldom that
blood loss exceeds 10% of the estimated circulating volume; therefore,
replacement transfusion is rarely indicated.

Positioning the child is of utmost importance to the surgeon, who sits at
the head of the table. The extension must be maximal for cleft palate
surgery, less extreme for lip repair. I prefer to obtain head extension by
raising the whole body on a folded blanket, rather than by placing a folded
towel under the shoulders. The work of breathing is decreased by this simple
manoeuvre.

At the conclusion of the surgical repair, and following a careful pharyngeal
toilet under direct vision, extubation is carried out in the surgical plane
of anaesthesia. To avoid trauma to the surgical field, an oral airway is not
used. Instead, a tongue stitch, combined with a lateral position, is utilised to
maintain a clear airway until normal reflexes return. The insertion of the
tongue stitch always seems to cause extreme anguish to the surgeon, but
having signed our "Mutual Aid Pact," it is now performed with a minimal
show of revulsion.

If it becomes necessary to administer oxygen to the patient before
protective reflexes have returned, a simple trick incorporating the tongue
stitch, mask and mask connector can be used. The tongue is pulled out by
the stitch. The stitch then is passed through the mask aperture, and the
mask connected to an oxygen supply. This is quite effective and technically
easy.

When normal protective reflexes have returned, the baby is transported
from the Operating Room to the Post-Anaesthetic Recovery Room. Here
arm splints are applied to prevent damage to the operation site by thumb
sucking. Some of the cleft lip babies will have been converted temporarily to
complete mouth breathers by the surgical repair. Gentle traction on the
tongue stitch may be required in the immediate post-operative period to
remind our little patients to open their mouths and yell a challenge to the world.

Many anaesthetists will ask why we go to so much trouble for these relatively short but challenging procedures. The answer is obvious some years later, when the eye can barely detect a scar on the lip, and the ear hardly detects a nasal tone. That, indeed, is sufficient reward.

Freeman

It has also been my good fortune to have another expert anesthesiologist, Alfred Freeman, M.D., trained at Temple University, available at Variety Children's Hospital to help in the care of these children. He is an extremely smart, dexterous and gentle man and has provided here the details of his approach:

Children's hospitals, because they are relatively small and because their staffs work closely together, provide what I believe to be the ideal environment in which to treat cleft lip and palate patients. It is important to have personnel who are specifically fond of infants and children and who can provide the emotional support that these patients require. Needless to say, teamwork is the keystone to the overall successful outcome in the treatment of these children.

Infants under two weeks of age are usually intubated under deep general anesthesia to allow for an atraumatic intubation of the larynx. Anatomic problems imposed by the cleft palate lead to easy impaction of the tongue against the palate with subsequent airway obstruction. Soft tissue obstruction of the airway will occur earlier and be more pronounced if the anesthesiologist inadvertently presses his fingers under the mandible and causes increased pressure of the tongue against the palate.

Halothane with 50% nitrous oxide/oxygen is usually used for the induction and maintenance. As soon as the patient is unconscious, a plastic cannula is inserted percutaneously into a peripheral vein and an infusion of appropriate fluids started. Monitoring of the patient's vital signs is started at the same time. A water mattress, warmed to 37° C., helps maintain the patient's body temperature at a normal level. When an adequately deep plane of anesthesia is reached, direct laryngoscopy with oral intubation of the trachea is performed. It is advisable not to use muscle relaxants in infants unless the anesthesiologist is experienced and has ruled out the possibility of anomalies which make direct visualization of the larynx difficult. When difficulty in exposure of the larynx is anticipated, it is wise to have the patient deeply anesthetized, saturated and breathing spontaneously at the time of laryngoscopy. During laryngoscopy, it is possible to
Tape ring indicates point of fixation to lower lip

insufflate the anesthetic into the oropharynx by means of a mouth hook to lengthen the duration of deep anesthesia and allow exposure of the larynx in a less hurried atmosphere.

The choice of laryngoscope blade varies from one anesthetist to the next. My personal preference has been the #1 Miller Blade up to six months of age, the #1 Flagg Blade from six to 18 months of age, and the #2 Miller or Flagg Blade for over two years of age. The #2 and #3 Mackintosh Blades also are useful on occasion.

The correct size endotracheal tube is that which will allow a slight leak of air around the tube when an airway pressure of 15 to 20 cm. of water is exerted, but no leak at pressures lower than that. It has been my experience that there have been no cases of post-endotracheal croup when an air leak at these pressures has been assured. Children who have a history of having had croup in the past (whether viral or post-anesthesia) and those with known subglottic stenosis, can be expected to accept a much smaller endotracheal tube than other children of the same age. The proper length to cut the tube will have the upper end of the tube at the level of the teeth or gums, while the bevel of the tube is in the distal third of the trachea, about 1–2 cm. above the carina. A right angle Magill adaptor inserted into the tube and directed caudad can be fixed to the lower lip without distortion of the corners of the mouth.

Recently, pre-formed polyvinyl chloride endotracheal tubes have been available commercially as shown. The pre-formed curves are designed to allow the endotracheal tube to lie flat against the patient and also eliminate the possibility of the endotracheal adapter becoming detached from the tube during the operation.

Where pressure of the mouth gag would threaten to kink (occlude) the endotracheal tube, a latex rubber metal-armored endotracheal tube of branchial length should be used. The ring of tape around the tube indicates the point of fixation to the lower lip to avoid endobronchial intubation. The extra length of the tube permits the anesthesiologist to position the remainder of the anesthetic apparatus at a greater distance from the surgical field.

After intubation an orogastric catheter should be passed to empty the stomach of gas and secretions and the catheter removed before preparation of the surgical field.

For cleft lip closure a small posterior pharyngeal pack is inserted deeply into the pharynx to help stabilize the endotracheal tube. For the cleft palate closure the use of the Millard-Dingman gag allows the surgeon easy unencumbered access to the field while stabilizing the endotracheal tube, without the need of a pharyngeal pack. It is important to properly position the patient to allow for the best possible exposure. For cleft palate repair, the entire body is raised by means of a foam rubber mat, 8 cm. thick, allowing
the head to drop back and be fully hyper-extended into a soft, round head support. This position provides good exposure while allowing blood to run downhill away from the larynx towards the nasopharynx from which it can be removed by suction.

To prevent injury to the eyes, the lids are taped closed by 1” cellophane tape, or ocular lubricant preparation is instilled into the eyes. The use of a 4 X 8 sponge held firmly over the proximal edge of the eye tape during the surgical prep will prevent any of the prep solution from running under the edge of the tape and into the eyes.

During maintenance of anesthesia the patient is allowed to breathe spontaneously. Gentle augmentation of respiration by the anesthesiologist’s hand on the reservoir bag is used since moderate depths of anesthesia are required to prevent coughing on the endotracheal tube should it be moved.

In recent years, I have found that one of the newer lightweight disposable carbon dioxide absorption circle systems offers the best anesthetic delivery. If a small extension of latex rubber is used on the Magill adaptor, this system provides minimal deadspace, low resistance, easy assistance of respirations and adequately humidified gases without the use of additional equipment. Scavenging of waste anesthetic gases is also more efficient with this type of circle system.

The goal of the anesthesiologist should be to maintain (1) clear unobstructed airway devoid of secretions, (2) adequately deep respirations, (3) a stable satisfactory level of anesthesia, (4) normal body temperature, (5) adequate fluid balance and (6) proper blood volume. Careful monitoring by the anesthesiologist will indicate proper management to achieve these goals.

There are differing opinions as to the management of the anesthesia upon termination of the operation. Many of these patients will be converted to mouth breathers as the result of the cleft palate repair and must therefore re-learn how to breathe to avoid soft tissue obstruction. It has been my experience that the lowest incidence of post-operative problems is encountered if the patient is extubated after awakening from anesthesia.

At the conclusion of the operation, the oropharynx and anterior nares may be carefully and gently suctioned and a small bite block (made from short lengths of tongue depressors wrapped with 1” adhesive tape) is inserted a short distance between the teeth and gums and taped securely alongside the endotracheal tube. The patient is then turned to the lateral position, taken to the post-anesthesia recovery room lightly anesthetized and allowed to breathe humidified oxygen by T-piece apparatus until awake. When the patient is able to open his eyes, the oropharynx (and trachea if necessary) is gently suctioned and the endotracheal tube removed. This technique does not require the use of a tongue stitch for traction. The use of sedative drugs in the post-operative period is discouraged until the patient can avoid soft tissue obstruction when asleep.
PREPARATION FOR SURGERY

As I noted in the Nursing Clinics of North America in 1967,

The patient should be relatively free of upper respiratory infection and possess a hemoglobin level of at least 10 Gm. He should be prepared for a postoperative routine by being fed with a spoon, cup or the Asepto syringe by various people using a good variety of liquids. Two weeks prior to the palate surgery, the mother can use a white cap and gown to prepare the child for hospital nurses [MacCollum].

In the older children and adults, in whom bleeding can be more extensive, a type and crossmatching for 500 ml. of blood is advisable, but seldom used.

POSTOPERATIVE CARE

Again as remarked in 1967,

It is important to remember that this baby has been used to breathing with a hole in the roof of his mouth. After surgery, this hole is closed and a new pattern of breathing is now necessary. The adjustment may not come easily. In addition, there may be some oozing of blood from the operative site. The baby should lie face down and suction should be available at bedside with alert nursing attendance for several days, particularly in the first ten hours.

Here again elbow restraints are applied to prevent the patient from inadvertently disrupting the healing palate. These restraints are maintained three weeks at home with short periods of controlled freedom. Because of
unavoidable and continuous contamination, a systemic antibiotic may be used for three to five days postoperatively.

With the aid of the Asepto syringe or cup, the baby is fed liquids the first two weeks following surgery. Each feeding is followed by a drink of water which serves as a mouthwash. During the next two weeks the baby receives a soupy diet. At one month, a regular diet excluding hard food such as toast and rock candy is begun. No straws are allowed for a couple of months from the time of surgery.

MORE DETAILS ON FEEDING

As an intern at Boston Children’s Medical Center, I learned from Donald MacCollum the trick of using a special feeding technique for cleft patients. As described in 1967,

The baby is held in the nurse’s arm with his head held upright in her left hand. Formula is fed by bulb compression through a 10cc Asepto syringe with a 1 1/2 inch rubber catheter extension. The catheter is slipped over the baby’s tongue and the formula is fed as the baby is able to take it. As soon as the baby has adjusted to this routine the mother is instructed in the technique. Once mother and baby are prepared by the nurse, they are allowed to go home.

THE BIFID NIPPLE

Kenneth Adisman of New York University has a 1957 patent on a Dow-Corning Company Silastic bifid cleft palate nipple designed for the infant whose sucking reflex is absent or minimal. As noted in Cleft Lip and Palate:

The liquid flows from the bifid nipple in a stream through openings directed laterally against the cheeks. The flared teat head, which serves to partially close the cleft opening, is compressed by tongue action against the maxillary process, expelling the liquid from the nipple. This bifid type of nipple construction enables these infants to suckle while in the usual feeding position without fluid entering the nasal cavity through the cleft opening. . . . The nipple is made in two sizes to conform to different shaped maxillary processes. The nipples may be provided with suitable venting means which will allow air to trickle into the bottle as liquid is withdrawn . . . thereby reduc[ing] the suction requirements for a satisfactory flow of liquid.
Here are Betty Jane McWilliams' thoughts on cleft palate feeding:

It is perfectly true that the babies usually do not gain as well as would be hoped if the mothers are left completely alone to develop a feeding plan by a trial-and-error method. Unfortunately, we reluctantly conclude that very little assistance is provided in the average new-born nursery and that the nurses are often quite uncomfortable about feeding the infants and about providing instructions to new mothers.

We were using a more complicated feeding system until one evening at a tiny neighborhood drugstore I picked up an Evenflo disposable nurser, plastic bags, and nipples, took them home and experimented. Next morning, Pediatrician Paradise was teaching a mother our old technique. I squirted him with the new bottle; he took it, tried it, and turned to the mother and said:

"Forget everything I've said. We'll use this," and we have ever since.

The system that we found successful for most babies with clefts is very simple indeed:

1. Hold the baby in a sitting position.
2. Use a plastic shell with openings in the sides and with no bottom.
3. Use disposable bags to hold the formula.
4. In the beginning, use a nipple for premature infants.
5. Be sure that the opening is a cross-cut. Never enlarge the hole. The cross-cut permits the milk to flow but also provides a good mechanism for preventing the milk from gushing into the baby's mouth and causing him distress.
6. The mother should learn to insert her fingers into the side slots and the bottom opening so that she can gently express the milk into the baby's mouth—being careful not to provide more help than the infant needs.
7. Burp the child frequently.
8. Attempt to complete the average feeding in no more than a half hour.
9. Follow a normal schedule for the introduction of solids including finger and table foods.

Evenflo disposable nursers (a) are not on the market now but may be ordered in quantities from Questor Juvenile Products, Ravenna, Ohio. In addition, Playtex nurser (b) may be used quite well by enlarging the slots of the sides so that a finger may be inserted. Both of these techniques permit the mother to use equipment that does not look "special" and that is much cheaper than are many of the special devices.
It has always been my feeling that well-planned, careful surgery and simple, practical postoperative precautions as noted are sufficient to achieve a well-healed palate. When in 1971 Sam Pruzansky wrote his approval of *Cleft Craft*, Volume I, he expressed disappointment in the chapter "Postoperative Care," mentioning that his wife, Donna, was an expert in this area. Although our babies were healing and gaining weight, long ago I learned to heed Sam’s cry!

For 10 years Donna Pruzansky at the Abraham Lincoln School of Medicine, Chicago, had been involved in a nursing outreach program which arranged for the visiting nurse, trained in the comprehensive needs of the child with an oral-facial cleft, to play an important role in crisis intervention by preventing potential feeding problems and assuring adequate nutritional intake during the critical neonatal period. This entails instruction of the parents, the hospital staff, and follow-up contact with the mother, and including home visits where required.

These were some of her suggestions:

Only minor modifications of the usual techniques used in bottle feeding are required to feed most CLP babies. To begin with, either a premie nipple or a lamb’s nipple (DAVOL, Inc., Providence, R.I.) is preferred. The lamb’s nipple is necessary in the case of a wide unilateral cleft lip and palate since the broad nipple will not slip into the cleft, thus allowing the infant to bite down against the alveolus and use the tongue to strip the milk from the nipple. This process obviates the need for feeding obturators.

The opening should be enlarged to facilitate flow. To do this, the nipple is turned inside out and a cross-cut is made with a scalpel or razor blade. Enlarging the opening in this manner, rather than merely enlarging the diameter of the hole in the nipple, allows the infant to control the flow of milk. This permits coordination of sucking, swallowing, and breathing and establishment of a normal feeding pattern. Adequate flow is critical to avoid unduly prolonged feeding periods which will exhaust the infant before he can complete sufficient intake. In contrast, nipple openings enlarged by poking holes with a hot needle result in flooding the infant with milk and necessitate a continuous insertion and withdrawal of the nipple to allow the baby to breathe.

There is no need to hold the infant upright, aim the milk at the cheek, or burp more frequently, as is so often advised in manuals for parents.
Helpful Hints

Since the lamb’s nipple does not fit onto conventional bottles with screw tops, it is necessary to improvise. A most effective arrangement is to cut the base from a conventional nipple and use it as an adapter.

The anxiety engendered by the malformation often discourages the mother from breast feeding. In our experience, successful breast feeding is contingent upon a number of variables that include the type and severity of the cleft and the dedication of the mother. Previous experience helps. Even then, it requires a longer period of time for each feeding.

The problem of feeding an infant with a cleft is complicated by the Robin syndrome where the maintenance of an adequate airway is compromised by the micrognathia and glossoptosis. The introduction of the nipple and milk further aggravates the problem.

Depending upon the severity of the condition, bottle feeding may be possible with certain modifications in posturing to maximize the airway. This can be achieved in some instances by holding the infant in an upright position with manual assistance to guide the mandible forward.

Feeding can be accomplished with the infant in the prone position on the nurse’s lap with head extended. For the severely compromised Robin syndrome, nasogastric feedings may be required.

Although the foregoing is limited to the neonatal period, parents can be assured that baby foods and table foods can be introduced to the CLP baby at the same age as for the non-cleft child.

It is an obvious but often overlooked fact that the baby with a cleft is first of all a baby. Like all babies, they may spit up, have allergies and a myriad of other problems unrelated to the cleft. Therefore, when problems do arise, it is important to examine the whole child and not focus only on the cleft.
II. Surgical Closure of the Cleft
8. Cautery or Paring and Suturing the Edges of the Cleft Palate

Just 10 years before the 13 North American colonies united to divide themselves from the British Empire, the first cleft palate was united, and both events were accomplished with French assistance. It may be true that Jacques Houllier, as reported by Rogers in 1971, sutured the edges of a traumatically split velum in 1552. Yet credit for the first closure of the congenital cleft palate must go to a French dentist named Le Monnier of Rouen. Believing that this most conspicuous and distressing deformity was amenable to successful surgical treatment, in 1764 he proposed an operation in three stages:

1. Introduction of sutures.
2. Cautery of cleft edges.
3. Bringing the freshened edges together and fixing them.

According to Robert, Le Monnier was the first to perform the operation, sometime between 1762 and 1764.

A child had the palate cleft from the velum to the incisor teeth; M. Le Monnier, a skillful dentist, endeavored and succeeded in reuniting the borders of the cleft, first inserted several points of suture in order to keep them approximated and afterwards abraded them with "the actual cautery." An inflammation supervened which terminated in suppuration and was followed by reunion of the two lips of the artificial wound. The child was perfectly cured.
Carl Ferdinand von Graefe, born in Warsaw, schooled in Dresden and Leipzig, at the age of 23 became professor of surgery at the University of Berlin. Three years later, in 1813, he became surgeon general to a division of the Prussian army during the Napoleonic Wars, received many medals and was consulted by royalty. In 1816 he introduced to the medical profession the first comprehensive surgical method for closing clefts of the velum. He presented his case most casually before the biweekly meeting of the Medical-Surgical Society of Berlin, and it was reported, in third person, early the following year in the *Journal of Practical Therapeutics*. This seemingly unimportant paragraph was translated from the German in 1971 by Karl Schuchardt for the journal *Plastic and Reconstructive Surgery*:

Geheimrath Graefe spoke about clefts of the soft palate, which could be congenital or acquired. He had tried several times in vain to cure the evil or to replace it artificially until finally, in the case of a cleft so extremely severe that it reached to the bone, he conceived the idea to unite it by suture and by an artificially caused inflammation. For this purpose he invented special needles and needle holders. With these he made a suture which, in conjunction with spreading it with *Acidum Muriaticum* and *Tinctura Cantharidum* (which latter he preferred for the excitement of the plastic process), achieved such perfect healing of the cleft that the person afterwards could swallow quite well and speak distinctly.

Philibert Joseph Roux, born into a family of French surgeons, in 1802 competed with Dupuytren for an important surgical position to the famous Hôtel-Dieu. As the story goes, a new post of Second Surgeon at Hôtel-Dieu was created specifically for Dupuytren, who was fast gaining renown. An upstart named Roux competed brilliantly and tied. In the playoff, each candidate was required to deliver a public lecture on some subject proposed by the faculty but not communicated to the contestants until four hours before the appointed lecture. One of Dupuytren’s friends in the faculty secretly informed him of the subject 24 hours ahead, and on this basis he presented the superior lecture and won the post.
There is a more intriguing story about the competition, told by E. Warren in 1860 and quoted by Goldwyn, telling of Dupuytren’s visit to an influential friend in a frantic effort to win this post:

Rushing into his room, he burst into tears, struck his head violently with both hands and cried out, “I am lost!” His friend tranquillized him and said, “Take courage. Go this evening to Madam B. She thinks favorably of you; will be flattered by your application, and gratified to exert her influence in the medical intrigue. She can turn the scale in your favor, if she chooses. Kneel to her. Pray to her. Say everything you can think of to excite her interest, and you will obtain the prize. Fly! There is not a moment to be lost!”

Although Dupuytren managed to defeat Roux in this competition, he lost in the next, as Roux married Dupuytren’s fiancée. Roux later became full professor on the faculty of medicine, University of Paris, was surgeon-in-chief at La Pitié, received the Legion of Honor and finally succeeded Dupuytren as surgeon to the Hôtel-Dieu. In 1819, in the Journal Universel des Sciences Médicales, appeared his most famous work, “Observations on a Congenital Division of the Soft Palate and Uvula Cured by Means of an Operation Similar to That for a Hare Lip.” This paper was translated from the French in 1971 for Plastic and Reconstructive Surgery by Daniel Morel-Fatio. It began with an acknowledgment by the editor that a Dutch surgeon named Itard had several years before proposed closing a woman’s cleft palate with stitches but the surgery had not been carried out because a more distinguished surgeon considered the chances of success nil. It was then explained that the operation by Roux had been a complete success and that details of the operation were of interest. The patient was a young medical student with a cleft of the soft palate and uvula who had typical cleft palate speech and was most anxious to correct it. Roux noted that the patient’s mouth was big and that the edges of the cleft could be brought together easily. Yet, realizing the operation was risky and fearing failure, Roux performed it almost in secrecy, with only assistants present. The report continues:

M. Roux passed 3 wax-threaded loops, using a curved needle placed in a handle. Then he drew together the wax-threaded loops so as to bring
together the two edges of the division, and thus evaluate exactly the extent of the loss of substance that he would have to inflict upon them. Half a line [*] of the soft palate and of the uvula was taken with great dexterity; the ligatures were drawn tight and the wax-threaded loops cut close to the knots.

Immediately after the operation, the voice returned almost to normal—with hardly any change. The patient was put on a strict diet for 3 days; complete silence was enforced. In a few days the two parts had come together completely, but the two lips of the uvula were not completely touching.

The editorial comment concluding this report hints at the beginning of a medical sophistication that would eventually give plastic surgery its great chance:

Although without danger for the patient's life, the operation corrected a malformation in an organ whose integrity is vital for normal swallowing and speech. It must be considered amongst those successful innovations which have increased the field of the curative art. It would be wrong to call attention only to operations which endanger the life of patients.

**PATIENT'S POINT OF VIEW**

Possibly of even greater interest than the medical report in third person of Roux's operation was the report in first person by his patient, John Stephenson, a Canadian who was studying medicine in Edinburgh. Stephenson wrote a graduation thesis in surgery in 1820 in which he explained:

The report will be authentic for the subject is one which I perhaps am best qualified to discuss, since I am myself the patient.

He then commented on his early loss of milk through his nose, the discovery of his palatal fissure, improvement in feeding with an upright position, a family history of one brother with a cleft uvula, pronunciation of th like s, his nasal speech, how because of its quality he found the French language easier than English and his inability to blow up a football or play on a wind instrument without closing his nostrils with his fingers.

* A line is the twelfth part of an inch, its use dating back to A.D. 1665, early in the reign of King Charles II of England, who "never said a foolish thing, and never did a wise one."—R. H. Ivy
While on a study visit to a hospital in Paris, Stephenson had occasion to speak with Dr. Roux, who immediately noted his abnormal voice and, with more candor than tact, asked if he had ever had a syphilitic ulceration of the palate. Whereupon Stephenson opened his mouth, and Roux, noting almost complete closure of the velar cleft during active movements of his fauces, pronounced the congenital cleft operable. Stephenson decided to have the operation while he was in Paris, for, as he said, a war might have prevented my return to Paris and a clever surgeon be deprived of well-deserved distinction.

At 4 P.M., September 28, 1819, the operation was performed. This is Stephenson’s own report:

I adopted a sitting position which seemed best to facilitate breathing and the flow of blood out of the mouth . . . .

Three interrupted sutures, stout enough to avoid laceration of the tissues, as far as possible, were introduced with two surgical needles alternately from behind forwards, each suture being thus drawn three times. Since fingers are too short to do the work at such depth, and the needles were rendered slippery by the constant flow of saliva, use was made of a stylus-like instrument (porte-aiguille in French) with what we call in English a slider to grasp the needles . . . . I suffered less from the pain than from the irritation and tickling caused by the introduction of the needles, a sensation that would run up to the ear like the pain of toothache . . . .

Before the edges were freshened the sutures were put in place in order to see whether the fissure could be closed . . . . The edges were thereupon cut with forceps and a guarded scalpel. The sutures were separately tied and severed.

The ligatures had been placed in position before the incision not only to see that the fissure could be closed, but also because the oozing of blood from the freshened edges, especially in the next stage, would have been troublesome both to the operator and to me. The union seemed to be as firm as skill could make it and nature’s healing inflammation would perfect the cure . . . .

Stephenson continued:

Immediately after the operation, in order to satisfy an inconvenient but understandable curiosity, I spoke a few words in the presence of Dr. Roux and some others. Everyone declared that my voice was considerably altered.
Thirteen days after his surgery, Stephenson, at Roux’s request, read a report of his case before the Royal Institute of Paris. He then set forth on his return to Scotland and during the Channel crossing from Ostend to Dover experienced seasickness and a dividend of his operation. To his great joy, he was able to stand at the rail 22 days postoperatively and vomit without his gastric contents being projected through his nose.

Stephenson concluded his thesis by admitting to some persistent nasal escape in his speech and justified it with

Who can deny the all importance of habit?

He suggested the operation be carried out between 4 and 6 years of age and
certainly before puberty to avoid all the disadvantages of habit.

He also suggested the name velosynthesis.

John Stephenson returned to Montreal and had a successful career. Honorable Peter McGill referred to him as
the man above all others to whom we owe McGill College.

Evidently unaware of von Graefe’s earlier, cursory description, Roux gave no credit in his 1819 publication. This omission enraged von Graefe, who had just finished the galley proofs of another palate publication. He attacked Roux for advertising an operation never performed before

and continued his attack with some heated logic:

This remark could hardly come from this physician, who is well read in the medical literature. The first palate suture was successfully performed by me in the spring of 1816.

He elaborated that later in the same year it was presented to the Medical-Surgical Society of Berlin, while lectures to large audiences were given in 1817 and 1819.

News of my operation must have reached Paris by traveling young physicians, as there is a lively exchange of students between the medical schools.
of Berlin and Paris. . . . Its existence could not have remained unknown to Herr Roux.

He continued:

I devised this operation in 1816 and performed it on four individuals. The operation was fully successful in only one patient. If I had had more experience, I might not have advised and performed the operation in patients like the one who had a wide cleft of his hard and soft palate, another who was anemic, and another who was cachectic.

Obsessed with gaining unquestionable priority, von Graefe proceeded to accept many more cases. His 1820 publication discussed a modification of his earlier method: denuding the defect borders with a uranotome and applying a bolt and nut device to hold the sutures. Seven years later he discarded these complicated appliances and used waxed, triple twine sutures held with a double knot. He also advised that sutures of catgut might be used.

Thirty years and 140 staphylorrhaphies after his first operation, Roux admitted that three years before this first procedure M. von Graefe had attempted the operation unsuccessfully.

THE FIGHT FOR PRIORITY

The eternal fight for priority was not first fought between von Graefe and Roux and certainly did not end there. Levi Lane said in San Francisco in 1896:

The method of Roux was the better one, and was so acknowledged by Graefe. A further investigation of the subject has brought to light the fact that the operation of closing the soft palate by suture was proposed to the French Academy in 1779 by Beziers. Priority here, as elsewhere, has proved a Protean entity, a flitting fugitive, which, though sought and temporarily possessed by rival claimants, has in the end escaped their grasp and fled to other hands. Such emulation, however, should be commended, since it is of generous source and is inspired by justice to give the palm to him who has earned it. Gold too often finds its way to the hand of him who has not earned it; the curators, by which the field of science is vigilantly guarded, do not permit such wrong; the earner is secured in his earnings, often through the mutual aid of his competitors.
A GLIMPSE THROUGH ZEIS

According to Tom Gibson, Eduard Zeis of Dresden, a merchant-banker’s son, was one of the great figures in plastic surgical history, having been exposed to the specialty during its period of greatest expansion by enthusiastic practitioners. In this milieu he was stimulated to write the first textbook of plastic surgery, *Handbuch der plastischen Chirurgie*, published in 1838, and later a great 1863 work, *Die Literatur und Geschichte der Chirurgie*, plus an 1864 *Nachträge*, all involving other surgeons’ work and experience, defining the scope of plastic surgery much as it is today.

Thomas J. S. Patterson of Churchill Hospital, Oxford, whose book, *The Essentials of Plastic Surgery*, with Peet, has been quoted often in these volumes, has become deeply involved with the Zeis Index for several years. Here is an excerpt from Zeis by Patterson:

Graefe conceived the idea of repairing the soft palate on the same lines as a hare-lip. He carried out the operation in 1816, and reported the first successful case on 27th December of that year to the Med. -Chir. Gesellschaft in Berlin. This arduous undertaking, calling for the greatest cooperation from the patient and perseverance on the part of the surgeon, excited general astonishment. . . . Soon after this, Roux, obviously incorrectly, claimed priority for this discovery, whereupon Graefe defended his reputation by describing his operation in greater detail in 1820. It took a long time for Graefe to achieve full recognition. Finally, however, Roux himself acknowledged that Graefe had preceded him, and excused himself by reason of his ignorance of the German language and literature.

The difficulties of this operation were so great that many surgeons quailed before them. Nevertheless a few soon copied the technique, and tried to make it easier by improving the instruments.

PALATE OPERATION BECOMES POPULAR

Following the success and rivalry of von Graefe versus Roux, surgical approximation was accepted by the medical profession as the treatment of choice for clefts of the velum.

John Collins Warren, professor of surgery at Harvard Medical School, who helped found the Massachusetts General Hospital, the American Medical Association and the *New England Journal of Medicine*, published a description of
an operation that he performed in 1819 for the cure of natural fissure of the soft palate.

He acknowledged that he had heard of cleft palate operations being done in Poland and Germany as well as by Roux in Paris but had "sought in vain for details of it." Thus, independent of von Graefe and Roux, he closed a soft palate on a 16-year-old girl in Boston, Massachusetts.

Thomas Alcock of London was the first in England to close a palate, an accomplishment that took about seven attempts on the same patient, using single knots and allowing early eating and speaking.

SMITH OF THE IVY LEAGUE

Nathan Smith, who studied medicine at Harvard, taught at Dartmouth and finally became professor of surgery and a founding father of Yale Medical School, noted in 1826:

Everyone must have observed that, when in early infancy the suture of the lip is properly made, the gentle pressure which the lip, then more straight than natural, exerts upon the cleft portion of the jaw, has a tendency gradually to approximate them, for at this time the bones of the face being yet in part cartilagenous, readily yield to little force.

Thus Smith decided to suture the palate and reported,

The operation was accomplished with less difficulty than I had anticipated. The margins of the palate were pared with the knife and a ligature of suitable size, with a needle very much curved, was carried through on one side, a sufficient distance from the margin, and brought back through the opposite. Two threads were employed in this manner, and the parts were brought into contact with very little difficulty.

STEVENS OF P AND S

Alexander H. Stevens was a young American doctor who during the War of 1812, while bearing dispatches to Europe, was overtaken by a British cruiser and imprisoned in Plymouth, England. Upon his release, he studied in London and Paris, and then, while
attempting to return to the United States, was thrown into prison again. After his final release and return to the States he was made professor of surgery at the College of Physicians and Surgeons of New York. In 1827 he was another pioneer in palate surgery and described his operation, but gave Roux credit for priority:

The patient being seated near a window, and his head thrown back and supported by an assistant standing behind, I interposed a handkerchief, tightly rolled up, between the molar teeth on the right side, and depressing the tongue with the left hand, introduced with the right hand a curved needle armed with a thread.

He then placed three sutures and, after paring the cleft edges with a cataract knife, tied and cut the threads. The patient was not allowed to speak or swallow for four days, at the end of which time Stevens removed the sutures and found the wound perfectly united. He reported that

On the fifth day . . . in the afternoon, he ate several pies and began to speak freely, but not with much improvement in his articulation. Supposing it might proceed from the division of the uvula, the parts of which hung like a swallow's tail from the end of the pendulum, I removed one of them. . . . On the tenth day, the voice was materially improved but far from being perfect.
9. Relaxing Incisions and Mucoperiosteal Dissections

DIEFFENBACH

JOHANN Friedrich Dieffenbach was born in Königsberg, Prussia. In 1813 the lure of the war of independence against France stimulated him to join his classmates in the Mecklenberg Cavalry. The love of horses developed during the war later caused him to have five fine mounts in his stable and his son to enter veterinary medicine. While he was in military service, his sensitivity toward the maimed and dying led him to write of his pity for the returning cripples:

To be handicapped is worse than death itself.

Thus inspired, he started his medical studies at the University of Königsberg at age 25. He completed his studies at the University of Bonn, where he admitted modestly:

I am born for surgery. . . . Technical and mechanical skill in my fingers allows me to do every operation with the experience of an older surgeon. . . . All my patients love me.

Everyone loves a winner, and confidence impresses students. When it came time for Dieffenbach to set off for the University of Berlin, his students gave him an unprecedented farewell. Familiar with his equine interests, they presented him with a horse and walked along beside it more than a mile outside the city gates.

Von Graefe was professor of surgery at Charité Hospital, University of Berlin, and Dieffenbach flourished in this plastic
c J b

milieu, eventually succeeding von Graefe as professor in 1840. Having been drawn to Paris as a young surgeon, he became a lifelong friend of Dupuytren and gained from exposure to Delpech and Roux. At this time the feud between von Graefe and Roux undoubtedly aroused some national partisanship, with German surgeons lining up behind von Graefe against French surgeons siding with Roux. Yet, as so often happens in medicine, the individual and the specialty rose above nationality. In 1826 Dieffenbach, who was under von Graefe, dared to write a small epitome on the Roux operation for cleft velum, of all things, and the illustrations in the back of his little book were quite explicit. They even explain why Roux’s patient, Stephenson, ended up with a split uvula. This act took courage, but, as once was said of Dieffenbach,

He was a bad dissembler, speaking his mind with such freedom and honesty that it kept him from many high places to which men less worthy were appointed.

By 1826, according to translations from the German by Eduard Schmid, Dieffenbach already knew that all mammals, and only mammals, had a velum, it having first appeared in the whale. He also had firsthand knowledge by dissection of the soft palate of mice, horses, camels and apes. It is little wonder that with such interest Johann was destined to make important contributions to the surgery of the palate of man. His 1826 Suture of the Palate mentions special instruments necessary for this surgery, among them a pointed bistoury and purified lead wire of moderate thickness, a precursor of Veau’s suture. Dieffenbach also divided the operation into three parts: (1) freshening the edges of the cleft, (2) insertion of the ligatures and (3) tying the knots.

Relaxing Incisions
Also in 1826 Dieffenbach described how he came upon the relaxing incisions so important in all of palate surgery:

At first the superior, then the middle, and finally the inferior ligatures were
placed. . . . After the sutures were tightened by turning, the wound mar-
gins were perfectly approximated. . . . However, palpation of the velum
with a finger indicated that it was under such tension that it almost
threatened to tear. Indeed, I already noticed a tear in the middle of the right
semi-velum. . . . To release this tension, and to ascertain the success of the
operation, I transected the anterior mucosa of the velum and the muscle
fibers of the constrictor isthmi faucium at both sides of the approximated
cleft, using an oblique cut with the knife which ascended in a lateral
direction. The unpleasant sensation of tension immediately subsided.

Dieffenbach was always striving for surgical excellence. He
taught that the skill of the surgeon lay in his hands, not in the
instruments. He pointed to the surgeon’s pen as his greatest
instrument to note ideas for testing against rules of physiology
and confirming with natural healing. What astonished visiting
surgeons as much as the design of his procedures was the awe-
some regularity with which his operations succeeded! The greatest
technical contribution to his generation was the extension of
Roux’s and von Graefe’s work on the soft palate to the closure of
bony defects of the hard palate. This was the operation that
Jonathan Mason Warren came to see and carried back to Amer-
ica.

His fame long outlived him and even exceeded the realm of
his surgery. Today’s popular dieffenbachia plant was named in his
honor; it produces speech difficulties when ingested. A German
national holiday, a street and a town all bear his name.

MASON WARREN

Jonathan Mason Warren, son of John Collins Warren, Boston,
was influenced by his early contacts with Dieffenbach and Roux.
His closure of the complete palatal cleft was an important step
beyond previous cleft closures and earned him a place in the
Dieffenbach-Warren-von Langenbeck procedure of modern times.
As he explained in the New England Quarterly Journal of Medicine
and Surgery in 1843:

I now carefully [dissect] up the membrane covering the hard palate,
pursuing the dissection quite back to the root of the alveolar pro-
cesses. . . . As the dissection approaches to the connection of the soft parts
with the edges of the *osa palati*, where the muscles are attached and the union most intimate, great care must be taken or the mucous membrane will be perforated, and from these causes I have found this part of the operation to be the most embarrassing. As soon as this dissection is terminated, it will generally be found that . . . the soft palate can be easily brought to the median line. If the fissure is wide, and this cannot be effected, French scissors are carried behind the anterior pillars of the palate; its attachments to the tonsil and to the posterior pillar are now to be carefully cut away, on which the anterior soft parts will at once be found to expand, and an ample flap be provided for all desirable purposes.

He used simple stitching logic:

Our next object is to insert the ligatures, and for this purpose an immense armory of instruments has been invented. After the trial of nearly all of them, I have found the most simple to be the most effectual. A small curved needle being armed with a strong silk thread, confined in a forceps with a moveable slide, is introduced.

At a second operation, the remaining hard palate cleft was closed, but Warren admitted the formation of a fistula and directed it to be closed by a gold plate.

Mason Warren became known for his palate surgery and treated over 100 clefts sent to him from all parts of America. In 1863 he summarized his experience, noting that 90 percent of the clefts he had seen had been complete, and added,

I do not remember to have seen a case in which the patient was not benefitted.

Robert M. Goldwyn, scholar, surgeon and ocean swimmer, who in almost all seasons can be seen bobbing in the high seas off Cape Cod, is also director of the Plastic Surgery Archives at Harvard's Countway Library. He has collected and published historical data about pioneer surgeons, and has been of great benefit in further vivifying several of the characters in the evolution of cleft surgery. For instance, it was Goldwyn who pointed out that J. Mason Warren had a remarkable collection of cronies befitting a plastic surgeon. None other than Morton did his anesthesia. Oliver Wendell Holmes, a lifelong friend who had been a student with him abroad, spoke of him warmly. Poet Henry Wadsworth Longfellow, a patient of his, told his father,
Truly it may be said of him that he has a high degree, "the eagle’s eye, the woman’s hand!" I know he needs no commendation of mine but it is so pleasant for me to say it. I trust it will not be unpleasant to you to hear it.

MUCOPERIOSTEAL DISSECTION

Dieffenbach “dissected the mucosa” or moved the mucosa with the bone, and Jonathan Mason Warren of Boston in 1843 “peeled off the mucosa” of the palate from the underlying bone. Yet credit belongs to von Langenbeck of Berlin for suggesting, in 1861, the dissection of the mucoperiosteum from the underlying bone in closing the cleft in the palate.

VON LANGENBECK

Here are some interesting facts collected by Goldwyn. Bernhard von Langenbeck, born in the town of Padingbüttel near the North Sea, had a boyhood interest in dissecting small animals which stimulated him to study medicine at Göttingen. He soon showed such competence as a clinician that he had to escape his eager clientele by “going out the window on a ladder.” His singular abilities on the battlefield during the Holstein wars caused him to be appointed in 1848 to follow Dieffenbach as chief at the University of Berlin. He was a small, precise, energetic man. He rose at 5 A.M. and, after coffee and a horseback ride, taught operative surgery on cadavers to graduates until 10 A.M., when he started surgery on private patients that went on for four hours. Then at 2 P.M. he entered his clinic operating room in his specially tailored, tight-fitting, black-green coat, which was scrupulously cleaned each day.

By 1859 von Langenbeck had resected a maxilla, leaving the periosteum intact, and noted bone regeneration. He extended this principle to cleft palate, using refrigeration anesthesia by applying ice on the palate region. He denuded the borders of the defect by removing a narrow strip of tissue cut on the slant. The levator and palatopharyngeus muscles were sectioned by an incision three-quarters of an inch long and placed at the posterior border of the hard palate with a sickle-shaped tenotome into the velum,
at a point external to the hamular process. The posterior palatine vessels were not divided. One or two lateral incisions were applied, parallel with the alveolar ridge and four lines (one-third inch) from it, beginning with the hamular process, or with the incision already made for muscle sectioning and running forward to the incisors. The mucoperiosteum was then cautiously separated from the bone (by specially devised raspatories) from without inward, extending the dissection backward to separate the velum from its attachments to the posterior border of the hard palate. When the flaps met in the midline, the sutures were inserted and tied. Von Langenbeck advocated silver anti-tension sutures, and he varied his incisions according to the plane of the palatal plates.

A. One palate plate horizontal, one vertical.  
B. Both plates horizontal.

Following von Langenbeck's contribution, success in this operation became more certain. Operators now attempted to restore the entire cleft, both hard and soft, performing a uranosphincterorrhaphy in one stage.

Throughout the evolution of cleft palate surgery, many heated controversies among surgeons have raged over the priority for operations. It is amusing that so much spleen and steam have been vented over procedures, the results of which are faintly heard and seldom seen. Having been involved myself in such, and finding confrontation, whether in the boxing ring or the operating room, both stimulating and fascinating, I shall record controversies whenever possible.
For instance, Frances Mason of London in 1877 noted that G. D. Pollock in *The Lancet* in 1862 had defended his countryman’s right to priority with this:

Mr. Avery [1848] . . . was the first surgeon in this country to close entirely a complete cleft of the palate. . . . The operation which Professor Langenbeck proposed [1863], and to which he gave the name of “the operation of mucoperiosteal flaps,” appears to be identical with the method of operating introduced by Mr. Avery.

Pollock also noted,

I need not add that the separation of the mucous membrane without including some of the periosteum is well nigh an anatomical impossibility because the two structures are so intimately connected . . . . It is highly probable that Dieffenbach performed a very similar operation many years previously.

Here is some enlightening material Tom Patterson sent me which appears in his *Zeis Index*:

This was the position up to 1860, so that Busch could write: “The surgery of defects of the hard palate gives such bad results that I only advise it for the treatment of tiny holes, by cauterization; it should not be attempted for larger defects, where one should be satisfied with palliative treatment—i.e. closing the gap between the nose and the mouth with an obturator.”

Zeis reported:

Since then, however, things have completely changed, due to the outstanding work of B. Langenbeck. He transferred his successful experience of rhinoplasty with retention of pericranium to the repair of cleft palate, and achieved such success that he was quite justified in saying that he was the first to have actually reconstructed the hard palate.

The operation, for which Langenbeck used the name “uranoplasty” instead of the older “palatoplasty,” is as follows: paring the edges of the cleft in the hard palate down to bone; dividing the palatal muscles (*levator palati* and *palatopharyngeus*); lateral incisions in the soft tissue near the teeth; freeing the mucoperiosteum of the hard palate with raspatories and elevators, so that it only retains an anterior attachment 1/3 inch wide behind the canine and incisor teeth, and a second, posteriorly, in the region of the pterygoid foramen; freeing the soft palate from the posterior border of the palatal bone; insertion of sutures.
In designing this operation, Langenbeck took great care not to disturb the blood supply of the mucoperiosteum which was to be transplanted, in that there were no incisions at the sites at which the pterygopalatine and sphenopalatine arteries send off twigs to the mucosa.

A number of cases on which Langenbeck operated in this way, and which were amazingly successful, prove that the transplanted periosteum forms new bone, as can be demonstrated by needle puncture. If repair of the soft palate is difficult, this operation is much more so, but this will not prevent it being assured of a permanent place in operative surgery.

Langenbeck’s statement that no one before him had succeeded in closing the hard palate by bone, caused Hulke to claim priority—partly for Ferguson and Pollock, and partly for himself. Whatever the first two achieved, neither Langenbeck nor I have ever read that they did anything like this. Hulke, however, after the description of Langenbeck’s first successful uroplasty was published in 1861, described his own unsuccessful operation which he alleged he had carried out in January, 1860; his account is so short and incomplete that it is clear that he has no right to dispute Langenbeck’s priority.

Up to now Billroth is the only one who has followed Langenbeck’s technique, using it even on children.

RELAXING INCISIONS

The permanent closure of the cleft velum by operation was not an easy task. The lateral pull of the palatal muscles interfered with healing and resulted in partial or complete failure in the majority of cases. This pull of the palatal muscles was feared by most operators, and ingenious efforts were made to combat it. Mettauer was one of the surgeons involved in solving the problem.

Mettauer of Virginia

John Peter Mettauer, son of a gallant French physician who had volunteered to serve with Lafayette in the Revolutionary War, after receiving his M.D. degree from the University of Pennsylvania returned home to Prince Edward County, Virginia, and became a plastic surgeon. He is credited with one of the first cleft palate closures in the Western Hemisphere, in 1827. Like others of this time, he was working under some disadvantages; it was 21 years before Lister’s aseptic technique and 20 years before Mor-
ton's anesthesia. Mettauer recognized that cleft palate was associated with speech deformity and advised that the most suitable age for the operation was near puberty, when the patient could evaluate the pain and privations of the surgery against the benefits to be gained. He preferred the summer for the surgery and sat the patient in a type of barber's chair turned for a southern exposure between the hours of 11 A.M. and 2 P.M. for the best light. He used a corneal knife to freshen the cleft edges and advocated a cold water gargle for hemostasis.

Horton, Crawford and Adamson attribute the first successful operation for a complete cleft of the palate in the United States to fellow Virginian Mettauer, citing his remark:

“We have met with cases of complete division of the palate in which the margins were separated to so great a distance as to defy every effort to approximate them, and to remedy them we were compelled to draw upon our inventive resources.

One of his resources was the protection of his suture line from tension with a series of small lunate relaxing incisions. He changed the axis of these incisions for palatal lengthening, stating:

Should the parts be deficient in length, the method which we have been describing may be employed in a transverse direction, guided by the views just submitted, but not to divide the tensor palati muscle.

Like most plastic surgeons, he was sensitive to deformity and even revealed this sensitivity in himself. Prematurely bald, he refused to be seen without his tall black stovepipe hat. One of his 17 children admitted never having seen her father without head cover since he always blew out the light at bedtime before he doffed his hat. He lived to the age of 88 and on his deathbed gave explicit directions that a coffin be constructed of sufficient length (8 feet) to allow him to lie in state comfortably with his top hat on and with a few of his special instruments by his side.

Liston

The Scotsman Robert Liston, professor of surgery at University College, London, was another early palate surgeon using relaxing
incisions. Liston was reputed to have tremendously developed arms and hands like those of Hercules or even another Liston, the "bad boy" boxer of the twentieth century. More amazing was the earlier Liston’s delicate dexterity in spite of the size of his upper extremities. In 1837 he described ambidextrous incising of the cleft edges, placement of relaxing incisions and suturing of the palate halves. He advised that

Before the ligatures are finally secured, the parts being put upon the stretch, an incision should be made on each side towards the alveolar ridge [by which] method the edges come together more easily, and the strain is taken off the threads, so that there is less risk of these making their way out by ulceration.

Addison

A more radical type of relaxing incision, still used in a modified form by some British surgeons, was proposed in 1925 by Addison. As he pointed out:

Tension in cleft palate surgery favors failure and sepsis assures it.

He threw all of his energy into relaxation:

The incision begins on the lower jaw and is carried up the ascending ramus on to the upper jaw behind the last tooth, then, turning inward, it is continued immediately internal to the teeth, as far forward as may be necessary.

Hullihen

Simon Hullihen of Wheeling, West Virginia, called a "Father of Oral Surgery," in 1845 reported on cleft palate and its treatment. From research by R. Goldwyn in 1973, interesting facts are available about this surgical pioneer. He was familiar with the work of Le Monnier and Roux and confined himself mainly to closure of clefts of the soft palate, being content to fill the osseous palate cleft with a gold obturator. Without the advantages of anesthesia, he had to wait until the child was 9 or 10 years old. The patient was placed on a low seat in a reclining position, in a good light. When he opened his mouth to its full extent, a cork was popped in between the last molar teeth. The
surgeon, kneeling in front, grasped the edge of the uvula with forceps in the left hand and, with a spear-shaped knife in the right introduced the point into the velum half an inch back from the palate-bone and the sixteenth of an inch from the cleft-edge, and then plunged through to the guard backwards and towards the pharynx. Thus, in an instant, the edge is severed in a straight narrow strip.

The cork was removed, bleeding allowed to subside, cork replaced and opposite cleft edge pared. The next step was to insert the ligatures.

**TRANSVERSE INCISIONS**

When the cleft extended through the hard palate arch, Hullihen considered closure difficult and explained his approach:

In such cases, a transverse incision may be made along the posterior edge of the palate-bone on both sides of the cleft, and through the entire thickness of the velum, and to such an extent as to permit the raw edges to be properly approximated.

Julius Wolff in 1885 stated that all suggested operative procedures for cleft palate up to that year could not replace the original formula laid down by von Langenbeck. He even went so far as to say:

Perhaps no procedure could ever replace it.

Three years later, however, he modified it himself, using two stages, first elevating the palatal mucoperiosteum, then, five to eight days later, denuding and uniting the cleft edges with sutures. With these improvements Wolff postulated that children operated upon in early life would learn to speak better by the age of 6 years.

**FRACTURE OF HAMULUS (BILLROTH III)**

Billroth used von Langenbeck’s method but added a new relaxing adjunct to facilitate closure with less muscle violation. Lenbach’s
enchanting portrait of Billroth, facts about him, and the translation of his paper "On Uranoplasty" by Leo Clodius of Zurich for *Plastic and Reconstructive Surgery* are of interest.

Christian Albert Theodor Billroth, born on the island of Rügen in the Baltic Sea, the son of a pastor, was a mediocre student with a desire to become a musician. He was skilled at playing the piano and violin, composed music himself and became a close friend of Brahms. Yet he was destined to become one of the great surgeons of his time. He studied medicine at Göttingen and Berlin and became a disciple of von Langenbeck. After seven years as professor of surgery in Zurich he took the chair at the University of Vienna. In 1881 he performed the first gastric resection and in 1873 did the first laryngectomy. Billroth was known for his sincerity in openly discussing his successes and failures. As he said:

One unhappy case is better than 10 good ones, if one does not hide the mistake but (rather) analyzes it.

In 1889 Billroth wrote of his modification of the von Langenbeck uranoplasty:

In many cases, the results of staphylorrhaphy and uranoplasty, introduced by B. v. Langenbeck, did not fulfill the expectations for speech improvement. . . . To achieve this goal, a number of trials were made. . . . In congenital defects, the muscles moving the soft palate are not just cleft, but powerless. This is the reason for the minimal postoperative speech improvement. In clefts of the soft palate alone, this muscle deficiency is minimal and, therefore, the postoperative functional result is best.

In clefts of the hard palate, the entire musculature of the soft palate, corresponding to the width of the cleft, is missing. In addition, these rudimentary muscles are transected by the lateral incisions.

During healing, the soft palate is pulled with the united soft tissues of the hard palate toward the vault of the hard palate, which, in these patients is usually quite high. These factors explain the functional insufficiency of the muscles and the slight improvement postoperatively.

To avoid this bilateral sectioning of the muscles by the lateral incisions, I did not divide the entire thickness of the soft palate in my last operations. After the mucosa was incised, the medial plate of the wing of the pterygoid, above the hamulus, was cut with a narrow chisel. In this way, the hamulus was rendered somewhat mobile and could be moved (from either side) toward the midline, with its uninjured musculature.

Despite all this, the ability to completely separate the nasal from the oral
cavity during speech was not achieved, in most cases, by the operation alone. Therefore, an attempt was made to close the remaining communication by a well-fitting obturator.

According to A. W. Schwartz, Billroth was so respected by the Austrian people that a two-shilling silver coin bearing his likeness commemorated his 100th birthday, and in 1937 his portrait appeared on an Austrian postage stamp.

In 1925 Dorrance fractured the hamulus and then dislocated the tendon of tensor muscle, claiming that this transformed its function from a tensor to a levator muscle.

MECHANICAL AIDS TO RELAXING INCISIONS

Other, more mechanical methods of reducing tension on the suture line were developed:

Champenois in 1868 packed the lateral relaxing incision with charpie and then covered the entire palate with a perforated gutta percha plate wired in place.

In 1879 Dudon inadvertently broke his curved needle. Not having another, he conceived the idea of holding the palatal flaps in apposition by embracing them with ribbon sutures passed through the relaxing incisions.

David Prince in 1884 took up the tension with beads.

Charles Dalton Fillebrown in 1906 carried the effort for relaxation even farther. He used special curved relaxing incisions and reinforced his cleft closure suture line with anti-tension wire sutures tied over silver disks.

Nitch applied aluminum plates at the site of lateral incisions to relieve tension in 1912.

MacKenty used retention hooks and retention retractors.

Federspiel in 1916 used anti-tension plates; Thompson in 1921
MacKenty used anti-tension sutures over lead plates; Sprague in 1926 used "tension relief pins."

Of course, all of these anti-tension maneuvers were superseded by the famous intramuscular silver suture of Veau.

**Dorrance**

In 1933 Dorrance described, with superb drawings by W. B. McNett, his modification of the von Langenbeck procedure, used when there was adequate tissue allowing sufficient length to be achieved without his more radical pushback procedure.

**Axhausen**

Georg Axhausen of the University of Berlin was a Prussian aristocrat with a dictator complex who, it is said, when not operating was fighting with Wassmund, the second maxillofacial surgeon in Berlin. In 1936 Axhausen wrote a book on cleft palate describing his use of the von Langenbeck procedure. He dissected the mucoperiosteal flaps through the standard lateral incisions, ligated and divided the posterior palatine vessels and achieved a careful two-layer closure of the nasal and oral mucosa.
Frank McDowell, now of Honolulu, Hawaii, recalled in 1976 how the von Langenbeck principle was used at Washington University, St. Louis, during the 40's:

All of us, Brown, Byars, myself, including Blair, closed total clefts of the palate by a modification of the von Langenbeck procedure which Blair called the Dieffenbach-Warren operation—and which was called by others “the Blair-Brown operation.” The arteries were dissected out well, stretched from their foramina, and cut loose from the mucoperiosteum a little ways, if necessary, to allow closure without tension in the area of the junction of the hard palate with the soft palate. (This was the forerunner of the setback operation for partial clefts.) The soft palate was closed in layers, paying as much attention to a precise closure of the nasal mucosa (from the anterior gum to the tip of the uvula) as to the closure of the oral mucosa. When done successfully in one operation at about the age of 18 months, about two-thirds of these would spontaneously develop normal speech (providing attention was paid to their incisor dentition so they could make sibilant sounds). About one-third had varying degrees of speech abnormalities—and they represented the real problem. We did see upper jaw retrusion in some of these patients—even in some who had not had the palate operated on—even in a few who had never had the lip or palate operated on. Early and persistent orthodontics seemed to be the best answer.

BLOCKER

Another to use or guide his residents through thousands of von Langenbeck cleft palate procedures is Truman G. Blocker, Jr., who in size, strength and "smarts" personifies the mythical Texan. A giant in American surgery, brigadier general in the Army, history addict and chief of the University of Texas Medical branch in Galveston, he learned the von Langenbeck operation from Singleton, who in turn learned it from pioneer cleft surgeon J. E. Thompson. Always with a clear view of the entire picture, Blocker developed an impressive residency training program and was the first to start a cleft palate speech program in Texas. Recently he has become president of the University of Texas Health Science Center in Houston, which includes the schools of medicine, dentistry, public health, biomedical science, nursing and allied health science. The Center, having bought the Prudential building, under Blocker's direction is busy removing the
“Piece of the Rock” sign and installing in its place the University of Texas steer head.

When asked to reflect on cleft surgery, Blocker wrote in 1977:

Sophistication of pediatric anesthesia in the past two decades has resulted in enhanced techniques for repair of cleft palate deformities. The surgeon has more complete freedom from worry for the safety of the patient than in former days and is able to define structures with much greater precision. Antibiotics have almost eliminated post-operative inflammatory breakdowns, and with anatomically correct approximation of tissues, problems in speech training have been considerably reduced.

MODERN POPULARITY

In 1964 Michael Lewin of Montefiore Hospital, New York, published a survey made in 1961 of methods of management of cleft palate in the United States and Canada. He found that over half the surgeons were using a form of the old von Langenbeck repair. This was certainly my experience during my early years of training. In the summer of 1944, as a senior student at Boston Children’s Hospital, I first saw a cleft palate operation. D. W. MacCollum, sitting on his special sponge cushion, pared the cleft edges, used relaxing incisions in a standard von Langenbeck closure, pulled the palatine vessels out of their foramen—as he said, “like an earthworm out of its hole”—and approximated the palatal halves with meticulous sutures. The primary concern was cleft closure without tension, and I do not recall an incidence of wound separation. There was no discussion about or attempt at palatal lengthening. W. E. Ladd had given up doing palates, but Robert Gross, between one patent ductus and another, did a private palate cleft occasionally—whether to keep his hand in or to upset MacCollum, I was never certain.

While finishing up World War II Navy duty in Nashville, Tennessee, I managed “off-duty” scrubbing in the early A.M. with William Core, an able general surgeon who occasionally did a palate operation. He was the first I observed to split the cleft edges instead of paring them, which seemed to make good “Scots” sense.

Through the latter part of 1946 and 1947 on the general surgical house staff at Vanderbilt University Hospital, I mane-
vered my way onto Beverly Douglas’ plastic surgery service. His complete concentration and minutely meticulous technique was beyond the patience of the eager general surgical students. One resident autoclaved the *Nashville Times* and kept up with current events during a prolonged plastic procedure, and Bill Meachum, once a circus performer but at that time more interested in neurons and synapses, faked a grand mal at the scrub sink and was excused from assisting a plastic case. Thus, I had the good fortune to spend many hours with Douglas on numerous Dieffenbach-Warren-von Langenbeck cleft palate operations.

**LINDSAY**

One of the modern champions of the von Langenbeck procedure is William Lindsay of the Toronto Hospital for Sick Children.

In the 1971 book *Cleft Lip and Palate* Lindsay mentioned that his operation is identical to that of von Langenbeck, with the only variant being in fracture of the hamulus.

Guided by von Langenbeck’s original text, which had no illustrations, Lindsay has conjured up likely diagrams to depict the various steps in the original procedure. Briefly, the operation includes the following maneuvers:

The edges of the cleft are incised and dissected to produce three layers: oral mucosa, muscle and nasal mucosa. The lateral relaxing incisions start at the maxillary tuberosity proceeding posteriorly along the pterygo-mandibular raphe to just in front of the anterior pillars of the fauces and then, proceeding anteriorly, parallel to the alveolar ridge as far forward as the canine-bicuspid region. The scalpel is carried firmly down to bone and with an elevator the mucoperiosteum is freed, taking precaution to tease the vessels out of the foramen without severing them. The nasal mucosa is transected at its medial margin at a point anterior to the posterior nasal spine and this cut is extended laterally, to try for a “sneaky” bit of nasal mucosal lengthening. This defect is left raw while the nasal mucosa, muscle and oral mucosa are sutured in layers.

A recent study by Lindsay comparing 66 von Langenbeck cases with 45 modified Dorrance pushback cases (also with a raw nasal defect) revealed interesting findings. Lindsay summarized:
The modern critics of the von Langenbeck operation claim that it allows unnecessary fistulas in the anterior aspect of the mouth, produces a palate of insufficient length, and is associated with inferior speech results. The evidence [of the Toronto study] contradicts these criticisms and indicates that patients who have a Langenbeck palatoplasty will speak as well as those who have a pushback palatoplasty by the time of speech maturation [60 percent acceptable speech by von Langenbeck, 42 percent by pushback]. This study has shown conclusively that the former [von Langenbeck] group . . . have a lower frequency of incisor crossbite and buccal-segment collapse. . . . It [also] suggests that it is better to leave residual fistulas in the anterior portion of the hard palate unoperated until after orthodontic correction has been accomplished.

In 1978 Isaac Kaplan, with Labandrer, Ben-Bassat, Dresner and Nachmani of Petah Tiqva, Israel, reported long-term follow-up on von Langenbeck cleft palate closures which supported the findings of Lindsay and Blocksma. There was minimal facial growth deformity with slightly more than 20 percent having velopharyngeal incompetence.

Personally, I find the von Langenbeck principle useful in closing the residual hard palate cleft at 18 months to 2 years when the soft palate was closed in the early months. The lateral relaxing incisions can be modified, kept away from the teeth and often reduced to curved releasing cuts around the maxillary tuberosities. This maneuver allows cleft closure with less muco-periosteal elevation and minimal residual raw areas with far reduced likelihood of maxillary growth disturbance. Since approximately 75 percent of patients with von Langenbeck closures will develop normal speech, the need for secondary pushbacks and pharyngeal flaps is limited to the other 25 percent and after 5 years of age.
According to Dorrance, Krimer was the first, in 1827, to use the important principle of everting soft tissue flaps from the covering of the palatal plates or the adjoining tissue. In his case Krimer made an incision along one side of the cleft. On the opposite side he made an L-shaped incision carried down to bone in the hard palate area. The flap of soft tissue was elevated with its base medially, turned over with the mucosa upward and sutured to the opposite split edge of the cleft. Thus the cleft was closed with one area raw and the halves of the uvula still divergent.

In 1830 Bonfils varied this principle with his turnover flap based posteriorly along the cleft edge to fill the cleft of the velum.

In 1836 Nélaton turned two Krimer flaps so that each filled half the cleft of the hard and soft palate and sutured them to each other in the midline. The wide raw area remaining must have been responsible for extensive scar contracture. The same principle, on a smaller scale, has been used through the years and is still of value for closure of fistulae.
In 1890 Davies-Colley made an important divergence from the popular von Langenbeck approach on a case in which the von Langenbeck method had failed. He combined the turnover flap of Krimer with a mucoperiosteal flap for overlapping. Four years later he modified the original procedure and used it in conjunction with staphylorrhaphy so that the split palate was closed in one operation.

LANE

In 1897 Sir W. Arbuthnot Lane of St. Bartholomew’s Hospital, London, pointed out the importance of establishing the palatal septum between the oral and nasal cavities. He advised operation very early to obtain normal breathing, a function he considered essential for the development of the involved parts.

Lane was Harold Gillies’ chief in the early days and, being interested in palate surgery, used his influence to help Gillies and plastic surgery get started in England. Lane was a general surgeon at heart, however, who was content to create and ignore large raw areas, and for adequate exposure to the palate he did not hesitate to split a normal lip. As an enthusiastic proponent of the “no touch” technique, he used long instruments to manipulate the tissues without once touching them with his hands. As Gillies said:

The old boy used the instruments with such dexterity that he could finish the operation in half the time of the rest of us.

In fact, the medical students affectionately cartooned Sir Arbuthnot Lane working with his famous long instruments through a hole in the dome of his operating theater.
Once Lane got onto the book-leaf turnover flap, he used frightening ingenuity in its application, warning that great care must be taken not to tear away this flap from the margin of the cleft. Here are variations of Lane’s turnover flap approach for various clefts.

For a split velum (in Dorrance):

For a complete unilateral cleft (in Dorrance):

For a complete unilateral cleft (in Davis):
For a very wide bilateral cleft in two stages:

First stage

Second stage

Sir Abuthnot Lane did develop a principle which has value. Yet, by carrying it too far, he became known as a bad knight in palate surgery. Our good and sensitive knight, Sir James Berry (a CL&P himself), in 1912 condemned eversion of the mucoperiosteum as practiced by Lane and others. You can almost hear his nasal escape as he made these pertinent comments:

That the [palate] defect can often be closed at the time of operation by this procedure is quite certain, but what is required is to know the subsequent fate of the flap and how the patient speaks. We have seen several cases in which the flap was undoubtedly atrophied and large holes have been left . . . ; in others it has been evident that the whole flap has sloughed and the palate been left in such a condition that further operation was quite impossible. The soft palate is frequently very deformed owing to the contracture of the scar tissue; moreover it is often stiff and rigid instead of being freely mobile. Most important of all, however, is the question of
At the demonstration of cases before the Surgical Section of the Royal Society of Medicine (May, 1911) very few patients were shown who had been operated on by this method and who were old enough to talk or to answer questions intelligibly; and therefore we are still left without reliable information on this important subject.

**COMBINING TURNOVER FLAP AND MUCOPERIOSTEAL FLAP**

In 1906 Murray used a turnover flap to close the hard palate in infancy and at 2 years medially displaced palate tissue to close the velum.

![Murray](image)

In 1907 Moszkowicz combined von Langenbeck's mucoperiosteal flaps with the Krimer-Lane turnover flap for palate closure. In 1908 Starr reversed the uses of the two principles, closing the hard palate with mucoperiosteal flaps and the velum with a turnover flap.

![Starr](image)
In 1917 Harry Shermann reversed Murray's order of closure by approximating the velum first and later closing the anterior cleft with a turnover flap.

SKIN GRAFTING THE EVERSION FLAP

J. F. S. Esser, during World War I, originated the split-skin graft inlay for reconstruction of the buccal sulcus. He must have spent a good portion of his surgical hours burying skin. In 1916 he described an interesting approach to closing a palatal defect with a turnover mucoperiosteal flap lined on both sides to avoid raw areas. On one side of the defect Esser made a crescentic incision down to bone as near the alveolar ridge as possible, then peeled the mucoperiosteal flap off the bone, leaving the base along the edge of the defect. At this point he had a turnover flap already popularized by Lane. He then fashioned a flat egg of modeling compound, wrapped it with a split-skin graft with its raw surface outward and tucked it into the raw pocket formed as the mucoperiosteal flap was brought back and sutured to its original join along the alveolar ridge. By one to two weeks the skin graft had adhered firmly to the raw undersurface of the turnover flap so that it could be relifted, folded medially, leaf-of-book fashion, and tucked under the elevated mucoperiosteum of the opposite edge of the cleft. This, of course, was an important improvement over other eversion flaps since it avoided one of the main flaws, a broad, raw, contracting surface. Esser recommended this method in all cases of bilateral jaw-palate clefts.
MODERN USES

Large eversion flaps producing huge raw donor areas were popular in the pioneer days of palate surgery. The undependability of the vascularity of these flaps and the severe contracture of them and their donor areas have reduced their use. Today the only turnover flaps being employed are the vomer flap for nasal lining in the hard palate area and various relatively small eversion flaps for closing fistulae.
11. Uranoplasty, Bone Flap and Osteotomies

FIRST URANOPLASTY

PALATE operations had been limited to single clefts of the velum until 1827 when Dieffenbach introduced his operation for uranoplasty or closure of the hard palate. His thoughts in 1826, as translated by Schmid, are of interest:

Several attempts to surgically close the bony gap with the soft cover of the palate have been unsuccessful. However, it might be possible by an operation on the bone of the palate to approximate the bones to one another and thus also the margins of the velum. After incising the soft cover, the palatine bones would have to be cut with a saw along the alveolar process in a curved line from the posterior margin in an anterior direction up... close to the cleft. After this, the freshened medial cleft margins would have to be pulled together by a gold or lead wire. The bone would have an adequate blood supply from its superior attachment; one could also expect later closure of the lateral opening, particularly if one provided some help to nature. After successful healing, suture of the palate would still have to be carried out.

Dieffenbach finally carried out his proposed osteal uranoplasty, demonstrating that his lateral mucosal incisions could be extended through the underlying bone with movement of both mucosa and bone toward the midline. First he punched a hole through the bone with a three-cornered awl on each side at a strategic position along the line of his usual relaxing incision. Then he passed a thick soft silver wire through these two holes, joined the ends across the cleft and began twisting. His lateral mucosal incisions were then made along the line where the palate
bone meets the alveolus. A smooth, thin, concave chisel was used to chop through the bone along this line. Dieffenbach explained:

The wires are then twisted again, till the edges of the bony cleft approach each other a little or together; the first alone can be generally done.

If he did not first succeed, he twisted again from time to time. Wutzer, a Swiss, in 1834, and Buehring, a German, in 1850, both used this type of osteal uranoplasty. Loewenhardt combined it with staphylorrhaphy in 1857. Another German, von Langenbeck, although not too happy with osteal uranoplasty, in 1861 pointed out that the procedure should be limited to bilateral lip-jaw-palate clefts and was contraindicated for unilateral clefts in which the vomer was attached to one side of the defect.

By 1868 Billroth was discounting the procedure as no longer being practiced, but in 1873 Sir William Fergusson came back into the act with new vigor and his special osteotome.

He modified Dieffenbach’s side incisions, placing them 0.25 inch from the border of the cleft using a chisel for the osteal uranoplasty. Finding that the bony fragments within the flaps became tilted, Sir William made perforations in the bone with a shoemaker’s awl to hold the bone flaps together with sutures. In 1874 he combined soft palate and osteal uranoplasty in one operation.

Francis Mason improved on Fergusson’s method by boring awl holes along the line destined for bone division. Then with the tap of a chisel the osteal uranoplasty was achieved without splintering. As Mason explained:

The procedure is extremely simple and may not be inaptly compared to the perforated edges of a postage stamp.

Evidently two gentlemen from Philadelphia, Roe and Mears, both did osteal uranoplasties in the late 1800’s. By the early 1900’s only two surgeons were using the bone flap method, G. V. I. Brown of Milwaukee and Warren B. Davis of Philadel-
phia. This operation has indeed enjoyed a rather discreet lineage, having been handed down almost selectively from teacher to teacher, each of whom, being a gentleman of the old school, always gave due credit to his mentor.

B R O W N

In his 1918 book, The Surgery of Oral Disease and Malformations, George Van Ingen Brown, D.D.S. and M.D., of Milwaukee Children’s Free Hospital wrote:

This method consists in sawing through the palate bones from behind forward, fracturing with forceps, and wiring in such a manner as to approximate the bone fragments sufficiently to bring the soft parts together. It was devised by Fergusson, and earnestly advocated for years by J. Ewing Mears of Philadelphia.

By 1922 Brown was using this method, pleased that it preserved the nerve and blood supply and did not require the severing of muscles which usually healed with shortening and inflexibility. He considered the bone flap method simpler and more certain of success and taught it to his students.

H Y S L O P

Volney B. Hyslop of Marquette University, Milwaukee, carried on Brown’s teaching, used the bone flap and taught it to Sidney Wynn. In 1973 Wynn recalled:

Dr. Hyslop was one of the best intra-oral plastic men I ever knew. It galled him considerably when he heard about all the secondary surgery people were doing on palates as less than 5% of his bone flap cases ever had to have secondary surgery for speech improvement. He was very kindly and did a considerable amount of charity work in the days of the house case and clinic before the time of Title 19 and Medicare.

D A V I S

Warren B. Davis of Philadelphia, in 1928, advocated what a Frenchman named Lannelongue proposed in 1877: the combina-
tion of osteal uranoplasty and the von Langenbeck procedure. In bilateral clefts of the jaw and palate he used the osteal uranoplasty, but in unilateral clefts he used an osteomucosal flap from the free side of the palate and a mucoperiosteal flap from the opposite side which was in connection with the vomer. In either case the resultant flaps were held together by a surrounding tape. Warren Davis acknowledged that William J. Roe taught him the bone flap method.

In 1964 scholar and researcher Lyndon Peer reminisced 25 years back when Warren Davis invited him, along with Staige Davis, Kitlowski and Straatsma, to visit Jefferson Hospital. During the morning Davis performed seven one- and two-stage palate operations and in the afternoon presented cases. The speech results and the palatal appearance and function were so impressive that Peer used this operation from then on at St. Barnabas Medical Center in Orange, New Jersey. In starched white coat and with his resonant and carefully modulated voice, Peer recalled Davis as an exceptional, skillful cleft palate operator who with John "Dermatome" Reese as first assistant and some adrenalin packs could complete the first stage in three minutes and the second stage in twenty minutes.

In 1954 Peer of New Jersey, with Hagerty, Hoffmeister and Collito, gave his initial description of this two-stage method carried out two weeks apart. First, an incision was made through the mucoperiosteum in the lateral palate at the base of the alveolus. A chisel cut along this line, dividing the bone and nasal mucosa. At the second stage, the bony palatal shelves were fractured toward each other and the mucosa of thin cleft edges
was split so the halves could be approximated with 2-0 silk sutures passed through drill holes in the bone. In complete clefts the anterior fistula was closed at a third operation. Peer believed that this operation produced better speech than the von Langenbeck method.

Peer's conclusions in 1954 from his study of 133 bone flap cases did not acknowledge deleterious effects on the maxilla. He reported:

1. No fistulae in 113 cases.
2. A majority of patients with very minor retardation in the anteroposterior growth of the maxilla associated with underdevelopment of the mandible.
3. A smaller percentage with "pushed-in" faces with slight underdevelopment of the maxilla but overdevelopment of the mandible.
4. Crowding and crossbite.

Peer considered these deformities typical of the cleft palate and not related to surgical trauma, the bone flap operation or the age at surgery.
Ten years later, in 1964, Peer’s report with Walker and Meijer still advocated the bone flap method, with 70 percent of the patients requiring speech therapy. For those who did not respond to therapy and whose palates were short, a full-thickness soft palate Z was used for lengthening. If even better velopharyngeal closure was required, a Moran type, superiorly based pharyngeal flap was added.

In 1971 Peer reviewed the advantages of the bone flap, emphasizing that it duplicates what nature should have done, for by moving the bones together not only is bony union achieved across the cleft but bone replacement fills in the lateral gaps, which I have seen in hundreds of cases.

He admitted, however, that if he started with a short palate he ended up with a short palate and he could not compare his bone flap method with the von Langenbeck or the Wardill as he had had no experience with either.

Stefan Demjen of Bratislava observed results in New Jersey of the bone flap operation carried out 8 to 10 years before by Lyndon Peer and reported:

The speech results are comparable to other methods presently used. There is no gross disturbance in maxillary growth.

HAGERTY

Bob Hagerty of Charleston, a student of Peer and one of the original authors of the early bone flap work, says today that he uses the bone flap technique in wide clefts and usually in older patients 14 and 15 years of age. He admits that some shortening of maxillary growth is seen but feels that this could be inherent lack from the original cleft deformity. Hagerty expresses more concern over the ill effects of dissecting mucoperiosteum off the bone than over osteotomies and fracturing of the maxillae.

CLODIUS

In the 1964 International Symposium on the Early Treatment of Cleft Lip and Palate held at the University of Zurich, historian and surgeon Leo Clodius stated his preference for the bone flap
method. Previously a student under Lyndon Peer in Newark, New Jersey, and representing a Swiss branch of the Peer part of the tree, he commented:

Closure of the palatal shelves and the soft palate is carried out between the 12th and 20th month before speech is started. The bone-flap technique originated by Dieffenbach is used. Unless the cleft is very narrow, this is a two-stage procedure, carried out two weeks apart. At the first operation the mucoperiosteal-osteal flaps are delayed, severing the palatal processes with the nasal mucous membrane from the palatal arch. This produces bilateral pedicle flaps. Their length is determined by extending relaxation incisions postero-laterally, as advocated by Ernst, to ensure tensionless palatal closure. At the second stage the flaps are united in the midline. A three-layer closure is performed for the nasal membrane, muscle and bone, and oral mucosa. The advantages of this method, which of course must be carried out carefully so as not to disturb the tooth buds, are as follows: there is minimal denuding of bone, the soft palate muscle attachment to the posterior bony palatal edge is left undisturbed and no raw surfaces leading to possible antero-posterior scar contractures producing velar rigidity result. A technically easy Z-plasty during the second stage may lengthen a congenitally short soft palate. A solid bony palate vault results. The resulting lateral defects are well healed at 10 days. . . . 70% of our patients are given speech therapy, many of these for minor speech defects.

W Y N N

Descendant of the Brown-Hyslop line and the most enthusiastic of them all, Sidney Wynn of Milwaukee Children's Hospital in 1959 described this method of osteotomy and suturing in one stage and defended its merit:

The bone flap technique provides a simple, relatively safe procedure which restores to the roof of the mouth a new bony vault as nature originally intended.

He further claimed:

Narrowing of the width of the palate is not secondary to early surgery on the palate if the bone flap technique is used.

He cited his work with Hyslop and Zwemer in 1956, which with study casts and cephalometric x-rays showed bone flap cases operated on between 9 and 18 months of age to have:
1. Intermolar width between the first permanent molars within normal limits.
2. The first permanent molars on the side of the cleft in the medial version or Class II relationship.
3. The teeth anterior to the first permanent molar on the side of the cleft in lingual crossbite relation.
4. The incisor teeth in both segments in lingual crossbite in a number of patients.
5. The teeth next to the cleft rotated and tipped toward the cleft.

Wynn continued his defense with:

The anterior crossbite is indicative of the rotation of the bony segments by labial muscular action of the repaired lip and is not due to the growth disturbance subsequent to the palate repair. . . . There is no broad surface scarring over the palate bone as there might be with a von Langenbeck mucoperiosteal type of procedure to interfere with the growth of the palate bones.

Then he went on to claim that not only is there no perceptible shortening of the soft palate but

In fact, it appears that the palate becomes lengthened following bone flap movement toward the midline.

Speech studies by experts such as Leutenegger and Demeter of small samples of postadolescents suggested that speech results following the bone flap method were as good as or better than those achieved with other methods. As noted by Wynn:

From 1936 through 1970 a total of 730 bone-flap operations were counted as having been performed at Milwaukee Children's Hospital. . . . Only nine pharyngeal flap operations were performed on patients who had [a bone-flap] procedure and whose velopharyngeal insufficiency appeared to warrant it.

"Blind" studies by Pionek of the bone flap method compared with other techniques using measurements taken on roentgenographic cephalograms revealed growth and development to be good, with the gonial angle more normal after bone flaps and increased to an obtuse angle after mucoperiosteal flaps. As Ross observed, cleft individuals with severely collapsed superior maxillae exhibited an increased gonial angle. It was postulated that
the higher vault following the bone flap method provided the unsuspected advantage of more room for the tongue. In 1970 Miller and Wynn reported that children with bone flap surgery had better hearing than those with other types of palate surgery and explained it on the basis of maintenance of better control of musculature essential for good Eustachian tube closure.

Finally, in 1976 Sidney Wynn repeated the advantages of the bone flap method but referred to it as “bilateral osteotomy cleft palate surgery,” justifying this change in name after 30 years to avoid confusion with earlier bone flap methods. He explained:

Our method should not be confused with the earlier procedures described by Dieffenbach, Warren Davis, G. V. I. Brown, and Peer. They actually divided the bone laterally, entirely through the nasal side of the palate, to produce a true bipedicle osteoperiosteal flap.

His description of certain advantages of the bilateral osteotomy method deserves consideration.

It consists of simple osteotomy wedging of the bone posteromedially leaving all nasal mucosa intact so actually a three-sided rather than a bipedicle-type flap is involved. The soft palate musculature is left attached completely to the bone and the hard palate is not subjected to mucoperiosteal elevation . . . yet when an osteotomy incision is made into a bone, an actual regrowth of bone may take place such as occurs in a fracture site . . . Bone fill-in happens rapidly . . . Dr. Walter Blount, eminent Milwaukee orthopedic surgeon, has reported that bone deposition has been observed when osteotomies of the bone flap of the pelvis are done in cases of dysplasia of the acetabulum. He stated, “the younger the infant, the more rapidly the bone fills in. This does not produce growth or bone developmental deformity and at times may even produce some bone growth.”

Confident that it is safe to do the bilateral osteomy palate closure as “early as 9 months with good results,” Wynn presented his various osteotomies and made statements that warm the cockles of the hearts of surgeons and speech therapists while constricting the orthodontists’ coronaries:

This over-emphasis on simplicity and trauma minimization to assist the maxillary growth, while completely overlooking the early speech results in a child’s psychologically formative years, seems to demonstrate inappropriate priorities. . . . Ortiz-Monasterio et al [1974] have reported that palatal
cleft palates also encourages more normal physiologic patterns both from the standpoint of speech and development by repositioning and restructuring the palate in the manner that nature originally intended.

The surgical technique is carried out through lateral mucoperiosteal incisions inside the alveolar area, starting behind the tuberosity and extending forward three-quarters of the length of the hard palate. The chisel osteotomy divides the hamular process off the perpendicular plate and extends forward as outlined in all types of palate clefts.
The edges of the cleft are stripped of mucosa and freed from the bone for a depth of 2 mm. to ease suturing. No attempt is made at suturing the bone, and packs of Furacin are inserted into the osteotomy sites for five days to relieve tension and control bleeding.

Upon removal of the packs, the large defects fill with granulation tissue in three to five days and are re-epithelialized by mucous membrane after two weeks.

Wynn noted:

Experience has taught us that in very wide (1.5 cm. anterior plus) single and bilateral complete cleft cases, it is easier and probably wiser to precede the osteotomy technique by a single vomer flap technique, as described by Dunn in 1952 [which according to Stenström in 1974 causes minimal maxillary growth interference]. In many cases, the bilateral osteotomy operation can then be used to close the remaining palate at the same operative procedure.

Wynn’s conclusions were enthusiastic as he claimed the following as benefits of the bilateral osteotomy method:

1. Reconstruction of the bony vault of the cleft palate. A photograph of an x-ray showed lateral bone fill-in in the osteotomy sites.
2. A soft, flexible and mobile soft palate.
3. Maximum function of the Eustachian tube, as their audiology studies demonstrated 10.6 dB better hearing levels than in children with cleft palate closed by mucoperiosteal dissection methods.
5. Vertical and horizontal development of the maxilla comparable to an unoperated cleft sample (McGowan).
6. A high percentage of good speech and voice results.

In spite of the experience of 30 years and 730 cases with what was referred to as “minimal complications,” only the nine years from 1966 to 1975 were studied, and out of 298 palate cases only 93 survived the various cuts. The operations had been performed by either V. B. Hyslop, S. K. Wynn or W. Wiviott. Of the 93, 88.2 percent had adequate palatopharyngeal functioning for speech and voice quality purposes. Eleven percent had hypernasal speech related to velopharyngeal incompetence which required secondary surgery; 19.4 percent demonstrated speech and voice deviations unrelated to palatal functioning since they had normal cithphonation findings and were stimulable for normal speech.
and quality with speech therapy; 68 percent presented normal vocal quality.

This closure makes no effort to correct malposition of muscle insertions by division and repositioning. Wynn defends the omission:

The muscles of the velum are not cut across and therefore a longer, more mobile palate is obtained. . . . Thus, the entire palatal bone with all of its muscular attachments moves in a posterior direction giving length to the palate. . . . Broomhead demonstrated some years ago that there is a nerve supply which comes through the aponeurosis of the palate. This of course would be disturbed if division of the posterior border of the palate bones from the musculature was done. . . . Recent work by Fisher and Mulliken and Kaplan [all in 1975] of the levator muscle retropositioning, retrodisplacement and reattachment I think should be reserved for secondary speech problem cases or those who have had intact bony palates with velopharyngeal insufficiency.

In 1978 in Hollywood, Florida, Wynn with K. L. Lynch reported gross, radiographic and microscopic studies of hard palate osteotomy sites at 7 days and at 12 months postoperatively. They reported:

The findings showed that successful osteotomy in infant cleft palate surgery translocates autogenous fibrous bone and osteogenic cells into a cleft bridging position. Rapid healing and bone formation bridges the cleft with woven fibrous bone initially, and then matures by lamellar bone replacement and Haversian system remodeling. Both the normal palate and the cleft palate have a rich anastomosis of microscopic blood supply that is vitally important in the remodeling process. These facts may help to explain long-term successful results in early cleft palate osteotomy surgery.
A most important aspect of the cleft deformity which influences the dental occlusion and maxillary platform for the face is the presence of a cleft of the alveolus extending through the hard palate. If the cleft does not go through the alveolus, there is usually enough buttress in the anterior bony arch to maintain occlusion with the mandible and resist distortions caused directly by the surgery or secondarily by postsurgical contracture.

The discrepancies in the maxillary and premaxillary segments associated with clefting present varying degrees of distortion. It is the nature of a surgeon to take up the scalpel or chisel to correct deformity, and, although many were content to use the compression of bandages or lip closure to mold the premaxillary protrusion, some were stimulated to take more radical action.

**Excision of Premaxilla**

In 1814 Xavier Bichat noted that P. J. Desault had removed the projecting bony prominence of the premaxilla in bilateral clefts and by three months all had healed. He also observed:

But the transverse diameter of the upper jaw, diminished by the whole width of the projecting button, did not correspond any more to the lower jaw, and as is often observed in old persons, there supervened a setting of the upper in the lower jaw, which was extremely inconvenient for mastication. This inconvenience, being the obvious result of loss of substance in the superior maxillary bone, changed the practice of Desault on this point.

He turned to external pressure against the premaxilla (presurgical orthopedics) with linen cloth bandages.
OSTECTOMY AND OSTEOTOMY IN UNILATERAL CLEFTS

In 1864 Dambre of Contrai closed the breach in the alveolar ridge in a patient with a left unilateral lip-jaw-palate split by pushing the projecting premaxilla into place after extracting the right second maxillary incisor. To promote healing between maxilla and premaxilla, he cauterized the edges with silver nitrate and fixed the parts with an ivory plate and T-shaped rod. In 1873 Duplay closed a unilateral alveolar cleft by pushing the projecting premaxilla into place after sectioning the bones subperiosteally from the right maxilla. He denuded the edges and, after wiring the bone, sutured the mucoperiosteum.

As noted by Conway and Stark in Plastic Surgery . . . One Hundred Years Ago, Gurdon Buck described osteotomy for unilateral clefts of the lip and palate in 1876:

The bony prominence formed by the anterior extremity of the right segment of the alveolar arch was first broken down and reduced into position by the application of Butcher’s bone pliers . . . The prominence, after it was reduced, bridged over and filled up the cleft in the alveolar arch. By previously paring the confronting edges bony consolidation was secured. The removal of this prominence also facilitated the approximation of the two halves of the lip.

In June 1882, in St. Paul, Minnesota, at the Dental and Oral Surgery Section Meeting of the A.M.A. Goodwillie described his method for correcting discrepancy in maxillary alignment in cleft palate:

By means of a small revolving knife and surgical engine, a V-shaped section was removed inside the alveolar process of the intermaxillary. . . . Just enough was taken away by the V-shaped section to allow the alveolus of the intermaxillary to resume its normal position.

After the ostectomy the premaxilla was bent and wired. Goodwillie operated “as early as the twelfth hour after birth.”

In 1892 von Esmarch and Kowalzig passed a chisel through the intermaxillary union so that the premaxilla could be turned on its axis and pressed into the cleft with closure of the soft tissue at the same time.
In 1893 Wyeth used an osteotomy to correct the continuity of the alveolar ridge in cases of unilateral lip-jaw-palate clefts when the premaxillary portion on the cleft side was absent. He fractured a segment of the maxillary bone distal to the cleft, moving the fragment forward to fill the gap and fixing it with wire sutures passed through the bone.

In 1896 Julius Wolff emphasized that, in cases of unilateral projecting premaxilla, normal pressure of the surgically united lip sufficed to restore the breach in the alveolar ridge. This same view was championed by Blair in the 1930’s.

Yet others continued to correct the premaxillary asymmetry in the unilateral alveolar cleft surgically. Schoemaker removed a horizontal wedge behind the projecting premaxilla in 1911.

In 1912 the gentle James Berry, with T. Percy Legg, suggested that minor unilateral projection could be ignored and the lip closed over it. Nevertheless, for cases in which they recognized that the projection was so great as to make lip closure impossible, they offered two alternatives:

1. Pressure by strapping for long periods, which they dismissed as “slow and not altogether satisfactory.”
2. Partial separation and crushing (with a pair of bone forceps) of the conjoined premaxillary bones from the maxilla in order to press the premaxillary bones back into the cleft.

In a typical example of his sensitive approach to this kindred deformity, Berry stated:

It is not desirable to effect complete reposition of the premaxillary bones. They should, however, be repressed sufficiently to enable the cleft to be closed over them. . . . The subsequent pressure of the lips and the growth of the maxilla will eventually correct the remaining deformity of the alveolar border.

In 1923 Ombrédanne sectioned the premaxilla with a broad, short-handled chisel. He showed some sophistication in his procedure by the way he lifted the mucoperiosteum of the edges of the alveolar cleft to prepare them for apposition and healing. He fixed the new position of the premaxilla with a wire suture passed through the bone.
Also in 1923, Truman Brophy of Chicago, in his book *Cleft Lip and Palate*, mentioned a patient who unfortunately had reached an age where the maxillary bones could not be easily bent and brought into proper relation.

At least the patient was thus saved from suffering the crushing transmaxillary wires over silver plates, a technique into which Brophy directed so much energetic force. In a modification of a method by W. L. Shearer, Brophy divided the external plate of the bone with a chisel, with a greenstick fracture of the internal plate, with the osteotomized fragment reduced into proper position with wires.

**MODERN OSTEOTOMIES IN UNILATERAL CLEFTS**

John Grocott of Stoke on Trent, England, in the 1973 *British Journal of Plastic Surgery*, reported 25 years of experience with primary maxillary osteotomies in clefts of the palate. Using an osteotome, he cut through the bone of incomplete clefts with the descending palatine foramen as the apexes of the triangle and removed the free bone (shaded). This maneuver allowed freeing of the arteries and also upward motion of the flaps, so that the soft palate reached a position much higher in the nasopharynx than it did with the conventional closure.

Grocott claimed flexible soft palates with minimal fistulae and no need for later pharyngeal flaps.

In complete unilateral clefts, to obtain greater symmetry he used an osteotomy to detach the premaxilla from the maxilla, and by prising it he displaced it across the midline, packing the defects with gauze soaked in Whitehead’s varnish. The raw bony edges made contact, and the anterior palate was closed with a von Langenbeck procedure. This technique has been used in only a few patients, but the results after two years seemed promising to Grocott. He was pleased with the symmetry of the premaxilla with the maxilla on the cleft side, and the area of the osteotomy has smoothed out, presenting a good alveolar arch.
OSTEOTOMY AND OSTEOTOMY IN BILATERAL CLEFTS

Surgical correction of the projecting premaxilla by Franco in the Middle Ages involved its total excision. Similar drastic action was employed by Dupuytren, Sims, Rose and others. Kilner preferred to keep it as a rack to support the middle third of the face, and if it remained wobbly at age 5 to 7 years he excised it and had the child fitted with a denture.

There have been a few surgeons on occasion who have been willing to scrap the tooth buds and part of the premaxilla and keep one bony plate covered with mucoperiosteum to wedge between the maxillary segments to achieve continuity of the alveolar arch. Gillies and Potter used this approach, and Masters added bone chips to bolster the arch.

Numerous surgeons, among them Gensoul, Pancoast and Innis, have carried out compression fractures of the vomer to force the premaxilla back and allow lip closure.

Then there were the multitude of surgeons who carried out vomer resection in various ways to allow setback of the premaxilla into the maxillary arch prior to lip closure. Blandin resected a pie wedge. Von Bardeleben divided the vomer and forced the ends to overlap. Variations of this approach were used by Pichler, Federspiel, Vaughan and Schultz. Denis Browne resected what he referred to as the "bony overgrowth" between the premaxilla and the vomer and held the premaxilla back in the maxillary arch with a toothed bar wired into position. He claimed a high percentage of bony or fibrous union across the clefts.

In reference to the Browne-type "set-back" of a projecting premaxilla, Matthews of London justified his small concern about this maneuver if bone grafts were added:

The surgeon can be reassured that in the very severe case where there is virtually no alternative, the end-result is not prejudiced by this radical operation. This observation is only pertinent, however, when these set-backs have been accompanied by bilateral grafts. . . . It is doubtful whether a "set-back" operation without bone grafts would produce a similar result. If this is true, it follows that if a set-back is done, a bone graft is obligatory.
Brown, McDowell and Byars resected a portion of vomer, pushed the premaxilla back and held it with a transfixion Keith needle. Cronin also resected the vomer, divided the septum and fixed the bones in setback position with a Kirschner wire. Kernahan and Burston modified Cronin's procedure by freeing the bones in setback position with a Kirschner wire.

There is an esteemed Spanish plastic surgeon who favors setback of the projecting premaxilla, considering this the greatest problem in cleft surgery. In 1971, B. Vilar-Sancho Altet of Madrid wrote:

My opinion in connection with surgical repositioning of the projecting premaxilla is, for the time being, favourable. I consider, therefore, that those who detract the importance of these techniques, overvalue the surgical action of the anomalous caudal apophysis of these protruding premaxillae, overlooking the fact that the real cause of the recession of the middle third is due to hypoplasia of the maxillae.

Most surgeons today avoid vomer resection for premaxillary setback when possible, or at least postpone it until it is absolutely necessary. Clarence Monroe of Rush Medical College, Chicago, avoids resection when possible but has no great concern when he feels it is indicated. In October 1971, he was accused with:

You remain one of the most radical surgeons when dealing with a projecting premaxilla, in what cases do you justify this with so much dental “flack” flying at you?

This was Monroe’s answer:

Even in those rare cases—such as have been reported—when the lateral lip elements are so far back of the premaxilla that they cannot be brought together with my fingers, then in my clinical judgment, I am unwilling to expose them to the risk of more radical treatment.

In her answer, Monroe was asked:

Even Pruzansky and Browne will tolerate later premaxillary setback in certain cases. When do you execute your resection?

I avoid vomer resection when possible but have no great concern when I feel it is indicated. In October 1971, I was accused with:

You remain one of the most radical surgeons when dealing with a projecting premaxilla, in what cases do you justify this with so much dental “flack” flying at you?

This was Monroe’s answer:

In those rare cases—I haven’t had to do one in a long time—when the lateral lip elements are so far back of the premaxilla that they cannot be brought together with my fingers, then in my clinical judgment, I am unwilling to expose them to the risk of more radical treatment.
And replied:

In the first 3 months of age at the same time as the lip closure. The setback is in undercorrected position by 2 to 4 mm. and the premaxilla is fixed with a pin as Brown described. It is often tempting to set the premaxilla back into contact with the maxillary elements. I have done this in the past but was sorry. With this undercorrected setback at 3 months, only one out of 20 has shown similar losses. Then, too, twenty cases with premaxillary setback have been comparable in growth and development with twenty cases in which the premaxilla was not set back.

William H. Olin of the University of Iowa wrote in 1978 of his opposition to surgical setback of the premaxilla:

While reading Cleft Craft II. I came across your report of the 1949 paper by Huffman and Lierle (page 66) in which they routinely surgically repositioned the premaxilla in infancy.

I observed these patients while they grew and followed them to adulthood and would like to report that they all have a serious mid-third of the face growth problem, as demonstrated in the cases enclosed. Lierle and Huffman recognized this severe underdevelopment and changed their technique.

OSTECTOMY AND OSTEOTOMY
Seldom Indicated

Early rubber band traction attached to a headcap will usually restrain premaxillary projection enough so that after a few weeks
the lip can be closed over the premaxilla. In a few cases, even with the lip closed over the premaxilla, the projection will continue to be too much, necessitating a resection of the vomer at 5 to 6 years for setback of the premaxilla in undercorrected position. Rarely will the premaxilla project so severely that the lip cannot be closed over it. In such a case, early conservative setback is justified if undercorrected and retropositioned only enough to allow lip closure.
13. Uranoplasty by Maxillary Compression

**Uranoplasty** or hard palate closure by maxillary compression is a procedure as old as any of the operations suggested for treating cleft palate. This compression has been achieved by three general methods:

1. Gradual external compression, exerted continuously by a truss with arms resting on both sides of the cheek over the maxillary bones until the palate edges are approximated.
2. Forcing the edges of the palate together by pressure, denuding bony borders and then passing wires through the bones to pull and hold them together.
3. Orthopedic appliances placed on the teeth with a crossed palate bar which is narrowed by a jackscrew.

**External Pressure**

In 1772 Levret of Paris elaborated on the importance of an early oral muscle sphincter union, in view of the fact that the edges of the palate are wide apart in adults without lip closure. He observed that in the newborn affected with a complete deformity the maxilla is larger than in the normal. In his opinion the cleft was due, not to a deficit of substance, but to a diastasis of the parts. Brophy, more than a hundred years later, made this the basis for his operation.

In 1836 Montin of Paris described his compression method with newborn children and reported union after three days. The
pressure, he pointed out, could fracture the maxillary bones, an incident he considered of no consequence in the very young. Other external compression appliances were used to push the maxillae together.

On the other end of the earth, Dr. Ziegler in the *Medical Record of Australia* advocated treating fissures of the palate with pressure. In 1851 he tried the idea on an infant cadaver with a cleft and then proposed:

The operation should be performed as early as possible after birth, when the bones are in their softest condition. . . . The edges of the fissure having been pared, the superior maxillary bone should be embraced by a horseshoe-shaped clamp . . . padded with India-rubber.

The clamp was set with a joint and screw to exert gradual pressure until the maxillary elements were in apposition.

Other "crushers" used ingenious methods to achieve their dastardly deeds. In 1853 Robert illustrated a method of three-point compression of the premaxilla and maxillae. Robert and Bonnafont remarked:

In effect the method of compression, which we stress, cannot be credited with one author, but as always, sums up the ideas which have preceded us.

Garretson had three ways in 1862: a Hoey clamp, a tight, circumferential rubber band around the head with rubber pads on the maxillae or the maxillo-occipital sling. In a collection of lectures delivered to the Bellevue Hospital, New York, in 1883, Sayre described closing a bilateral lip cleft after birth, and then continued:

A compress was placed on either side of the superior maxillae, to bring these bones in apposition and close the cleft in the palate. At the time of the operation the fissure in the palate was wide enough to admit the finger. Compression and lip closure by the time of puberty brought these surfaces so close that further treatment was needless.

Then there followed an army of "squeezers." Hammond used a clamp in 1909; Shea used a bar, gaskets, plates and nuts in 1912; Ulrich conceived this crab claw in 1913.
Truman W. Brophy, D.D.S., M.D., professor of oral surgery at the Chicago College of Dental Surgery, was a forceful, dogmatic leader. He was so dynamic that he managed to be president of the American Association of Plastic Surgeons for 1921, 1922 and 1923, arranging for the meetings to be held in his hometown of Chicago two times out of the three years. Interestingly, in 1904 Brophy attributed to Sayre the following statement:

Gentlemen, you see I am able to almost approximate the edges of the cleft palate. If we had some plan by which we could bring the tissues in contact and hold them there until nature united them we would be able to cure this defect. But we cannot do it.

Evidently Brophy was challenged by this admission. He was also confident in the misapprehension that all necessary tissue was present in each cleft. Thus the persuasive Brophy championed the gradual compression by wiring method. As early as 1904, in a plea for palate operations in early infancy, he declared:

Cleft palate is not the result of arrested development or insufficient tissue to form a normal palate.

Years later Sir Arthur Keith wrote to Truman Brophy:

I agree with you in the majority of cases of complete cleft of the palate there is no deficiency of tissue at birth nor for some time after birth. I also agree that the cleft, however wide, is not due to a deficiency of tissue in the several elements which form the palate, but is entirely due to the fact that when the various embryonal parts are developed and come together in the second month of development, the process of union is delayed and does not take place, hence . . . [they] tend to separate as growth occurs, the cleft increasing during each month of growth. The exact cause of the separation of parts and the enlargement of the cleft is probably due to several factors, tongue pressures, muscle tractions and also the independent process of growth in each part. Theoretically, the best treatment ought to be to bring union at the very earliest date, but theory and practice may not be easily harmonized. Although you [Brophy], Arbuthnot Lane and James Berry have reached diametrically opposite conclusions as to which is the best time to operate, that still does not influence me in agreeing with you that to secure a good palate the sooner the cleft is remedied in complete cases the better the result ought to be.
In 1923 Brophy repeated his stand:

I am sure that anyone interested enough to enter into careful investigation of this subject, no matter what his previous opinions may have been, will be convinced that at birth a cleft palate, with rare exceptions, has in it sufficient tissue to form a normal palate and that the abnormality is only a separation and elevation of well-developed parts.

Having launched a direct attack, Brophy then reinforced his position against any doubters:

I have no doubt that an adult, growing up with a cleft palate, has not the full complement of tissue that forms a perfect palate since this tissue has failed to develop in proportion to other parts, as it has not been subjected to the uses for which it was intended.

In his 1923 book, *Cleft Lip and Palate*, he explained his pressure technique:

The bones of the hard palate are not crushed together or broken but they are bent and moved into correct relation and united.

He suggested that one operate in early infancy on the bones of the hard palate, then, as soon as expedient, upon the lip and finally, when the child is 16 to 22 months old, upon the soft palate.

In describing his method of closing the hard palate, he explained how his pilot sutures of silk guided 20-gauge wire through the maxilla above the hard palate and crossing the fissure. These through-and-through wires were passed through lead plates laterally so that with twisting of the wire the maxillary elements moved together. The mucosal edges of the cleft were split so that a nasal and oral layer of sutures could be accomplished as the bony elements were bent together by wire compression.

**UNDER THE BROPHY SPELL**

In 1909 Vilray Blair of St. Louis described his method of narrowing lip-jaw-palate cleft by forced compression. He passed wires through the maxillae at the level of the floor of the orbit to
avoid penetrating the tooth germs and safeguard them from sloughing. After narrowing the cleft, he closed it by displacing mucoperiosteal flaps mesially.

In 1914 Eastman was using malleable iron wire twisted over aluminum plates cushioned with rubber pads. In 1921 Thompson was using lead plates and silver wire.

To emphasize again the breadth of Brophy’s influence, here is a quote from an article by Sterling Bunnell of San Francisco in 1927, long before he became infatuated with the hand-and-tendon pullout wires:

Brophy, whose experience is great, stresses the need of closing the cleft early. . . . Soon after birth the alveolar processes are pressed into alignment and held there by Brophy’s method of wires and plates.

Bunnell then devised a perforated silver plate with extensive wires fixed to a plaster headcap to act as a false palate and protect his mucoperiosteal flap closure of the cleft.

As late as 1930 Ritchie used thumb pressure to take the spring out of the bone and then with a Brophy awl and No. 20 silver wire he encompassed the wayward maxillae, bringing the wire ends out in front of the cleft. With a few good twists of the wire he forced the bony parts into so-called normal position. He modified his wiring for unilateral and bilateral clefts.

Gerald O’Connor of San Francisco, aged 71 and not long before his death, wrote this of Brophy:

He was a very forceful man, gave many lectures, wrote books, did about 5 to 10,000 cases himself. Dentists, surgeons, and orthopedists, almost everyone fell into line with him and it took about 25 years before the damage was recognized. William Shearer (Omaha), Al Davis (San Francisco), Warren Pierce (San Francisco) were using his method as late as 1930–1935.

REACTION AGAINST COMPRESSION
BY WIRING

In 1905 the perceptive Sir James Berry scored another victory as he ruled out closure of cleft palate in infants by forced compression:
The violent operations upon the maxillary bones themselves, I think, may reasonably be left to those who prefer to overcome difficulties by force than by craft.

In 1914 Drachter stopped guessing and got out his calipers. Comparing extensive measurements of the normal and cleft palates of the same age, he showed by these measurements the fallacy of closing the cleft palate by forced compression. Drachter pointed out that, in unilateral and bilateral lip-jaw-palate clefts, adjustments of the projecting premaxilla and closure of the lip cleft sufficed to place the palatal plates at the optimal stage of approximation.

In the early part of the twentieth century Vilray Blair made regular trips to Chicago to observe the work of Brophy and Gilmer. After using the Brophy procedure for some years he became disenchanted and in 1923 dealt the principle a blow with the typical poignant clarity which always set him above his peers. He said, simply:

Wiring of the maxillae is sometimes followed by most distressing distortion and lack of development of the upper jaw. The changes are rarely very evident in early childhood, but when seen at the age of 12 or 15 years may cause the operator to regret that this particular child was not one of those infants the angels had chosen for their own.

According to Sarnat, who was one of his students, Blair eventually turned to the Dieffenbach-Warren operation.

William H. G. Logan of Chicago, Brophy’s son-in-law, at first embraced Brophy’s method but later dared to abandon the compression method and turned to the von Langenbeck procedure.

In 1927 Ernst pointed out that forced compression of the split maxillae as done by Brophy was the most unphysiological cleft palate operation. He designed a kinder appliance.

As one of Brophy’s early pupils, Bill Shearer of Omaha, to the end of his days, was an ardent proponent of Brophy’s theory and techniques in clefts and hotly defended them against all critics. At a meeting of the Association in Boston in 1929, one year after Brophy’s death, Robert Ivy recalled that Shearer, after listening to several rather severe judgments on the Brophy method, was so overcome with emotion that he actually broke down and cried.
Victor Veau in his 1931 book, *Division Palatine*, spoke against closure of the split palate by forced compression. In 1932 Ruppe, while writing about Veau’s approach to cleft palate, said that Brophy’s compression principle in split palate,
in which the two upper maxillaries are approximated, has no anatomical basis. Suitable measurements have shown that division of the hard palate is not due to abnormal separation of the upper maxillaries.

Gerald O’Connor of San Francisco, who trained with Gillies in the late 1920’s, reported:
Pierce and Davis finally changed from the Brophy wire compression after I returned home in 1930 and reported the world-wide feeling against the procedure. In the meantime I had taken out many plates and wire with the usual result of great gaps in the palate with loss of tissue.

**ANOTHER STUDENT WHO BROKE THE SPELL**

With the help of Robert Ivy, I located oral surgeon J. Orton Goodsell in Pompano Beach. He had trained with New, Figi and Lyons in the early days and later served as director of the Saginaw General Hospital Oral Cleft Habilitation Center. In 1972 Goodsell recalled, 50 years ago, holding retractors around the “oral hole” for Chalmers J. Lyons, professor of oral surgery at the University of Michigan, Ann Arbor. Lyons had trained with Truman Brophy and was doing a large volume of work. While on a European trip, he mentioned in Vienna that he did two or three hundred oral cleft operations annually. This caused an Austrian surgeon, who was certain Lyons was overstating his experience, to follow him back to Ann Arbor, but after several months he returned to Austria convinced and impressed. Goodsell remembered:

Our surgery was the Brophy “silver wire” compressor of the maxillary components that succeeded in destroying dentition and making an inverted “V” instead of a “U” out of the alveolar arch. One of the first innovations by Dr. Lyons was discarding the silver wire technique and, as far as I know, he was the first one to bury submucous sutures in the soft palate muscle... Some of your very competent men—Reed Dingman, Bob Harding and Cliff Kiehn—trained in our University Hospital Oral Surgery program.
The third and most sophisticated dental method for moving the maxillary elements together was achieved with orthopedic appliances attached to the teeth. In 1918 G. V. I. Brown developed a cap splint type of appliance which he cemented to the teeth to pull the maxillary elements close enough so that he could accomplish a von Langenbeck palate closure. He used a maxillary osteotomy to aid the shifting of the bones.

Of course, we know now that all these compressions were being exerted in the wrong direction. Surgeons obsessed with closing the hole stayed awake at night dreaming up ways of collapsing the maxillae to ease their palate closure. Thus, the normal arch was being destroyed, with resultant crossbite and other deformities of malocclusion. Since Brophy’s empire was centered in the Chicago area, it is logical that surgeons and dentists continually facing these collapsed arches would sooner or later begin to react against the principle that had caused such dental disasters, and finally they did!
14. Early Soft Palate and Later Hard Palate Closure and Lip Adhesion

It was inevitable that those seeing the long-term results of constricting wires and surgery too radical and too early would note the damage being done and speak out against it.

Slaughter and Brodie, then Pruzansky

This lot finally fell to Wayne B. Slaughter and Allan G. Brodie of Chicago. Slaughter, chief plastic surgeon to the University of Wisconsin Medical School, Loyola University Medical School and Chicago College of Dental Surgery, inherited not only Brophy’s instruments and records but his actual cases! Brodie, chairman of the Department of Orthodontia, University of Illinois, and for over 10 years dean of the College of Dentistry, combined basic science in anatomy, physiology and growth with clinical practice. His research and teaching reflected these interests bringing him many national and international honors. He also took time to reflect, most successfully in August in his cabin at Bear Lake, Michigan, where he waded trout streams casting a royal coachman (Western style) while humming “Pomp and Circumstance.”

These two, then, Slaughter and Brodie, joined together and started the pendulum swinging in the opposite direction with their 1948 presentation in Boston to the American Association of Plastic Surgeons. They set the stage for their attack by a review of
the normal. They noted that in the face there is a generalized growth on almost all surfaces of all bones until about the fifth year, after which the surface growth tends to disappear. Certain active sites of growth remain and continue to grow at a high rate almost until the completion of growth. Their longitudinal studies of children with clefting defects revealed the same pattern and they hypothesized that clefts represented a temporary aberration of growth, probably of short duration, during early intrauterine life. Once recovery occurred, however, the various parts pursued now relatively normal paths and rates of growth. The original distortion remained but it became no worse unless a specific growth or adjustment site had been permanently affected.

The tuberosity of the maxilla growing backward against the pterygoid process, a fixed base, is the agent responsible for the forward development of the middle face. An equal amount of growth occurs in the palate at the transverse suture. It occurred to Slaughter and Brodie that reduction in blood supply and constriction by scars in these areas may jeopardize growth. If it does, then unwarranted trauma to soft tissue and interference with blood supply and fracturing of bone and stripping of mucoperiosteum may cause permanent damage to growth sites.

For five years Slaughter operated with this idea in mind on 1,349 clefts. Measurements were taken with cephalometric x-rays, the axial ray passing through the external auditory meatuses, head plates, plaster molds and photographs. The Frankfort horizontal plane was used to relate cranial and facial structures. Three examples of their tracings are shown: (1) A normal 12-year-old male; (2) a 19-year-old male whose cleft lip was closed at 19 months and palate at 12 years; (3) a 23-year-old female whose unilateral lip and palate cleft received surgery once a year for her first 14 years.

Simple atraumatic surgery was advised with closure of the lip portion of a bilateral defect in two stages, an obturator being used for the alveolar and hard palate cleft.

They summarized their stand:

Surgery can and does inhibit normal growth. . . . Congenitally deformed parts, unless permanently damaged, grow at normal rates. . . . [Thus] surgery poorly executed or poorly timed, can do more damage than good in the long run.

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Five years later, Slaughter was joined by Samuel Pruzansky, orthodontist and research fellow from the National Institutes of Health. They presented the rationale for closure of the velum as the first palate surgery at the meeting of the American Society of Plastic and Reconstructive Surgeons held at Coronado in 1953.

Kirkham, Wardill and Psaumé had already shown by hamular measurements that lateral dimensions of the nasopharynx are greater in cleft palate individuals than in the normal. Subtelny had studied pterygoid plates by frontal cephalometric laminography which revealed not only a break in the structures but actual distortion.

In a cleft, without the muscle band of restraint, the tongue pushes the maxillary elements out of mandibular alignment. The dental arch and alveolar processes are normally molded around the tongue by the action of the buccinator and lip muscles. The same distortion is being promoted by the lateral unopposed tension of the levators and tensors pulling on the palatal elements. If closure of the lip muscle molds the anterior arch, thought Slaughter and Pruzansky, why not close the muscles of the velum? This single act would mold the maxilla, reduce unopposed muscle action, prevent tongue entry into the cleft and actually diminish the cleft itself. They proposed merely to pare edges and approximate mesoderm across the cleft to present more normal physiology for growth and development.

In a series of 200 simple velar closures the outcomes varied. In one complete unilateral cleft the lip was closed at 3 weeks, narrowing the cleft with some overlap of the alveolar processes. The septum tended to straighten, and velar elements neared each other and became larger. At age 11 months the palatal parts could be approximated, and a decrease in the hard palate cleft resulted. The alveolar overlap improved as the maxillary segment on the cleft side increased in antero-posterior length. Facial growth continued in normal fashion. There was downward and forward migration of the floor of the nose with uprighting and elongation of the nasal septum. (This is one reason they were against use of portions of the septum in palate closure.) A random study of other cases in the series of 200 showed one case with reduction
of the width of the cleft and increase in the bulk of the soft palate parts to make velar closure possible at 22 months; another was not ready until 3 years of age and another, not until 4 years!

Thus did Slaughter, with Brodie and later Pruzansky, start the cleft surgical pendulum swinging in the conservative direction. Slaughter, having the face of a fighter and qualities of a champion, prompted me to inquire into his sports achievements. I found he had held the Missouri Valley cross-country record and, in 1931, while at Nebraska, had been a member of a world record half-mile relay team. He had another claim to fame, which no doubt had been a source of amusement to him but is appreciated by some surgeons more than others: He trained a tiger in Pruzansky and turned him loose in our midst, where his roars and the rip of his claws have been heard and felt from time to time.

Slaughter and Brodie reviewed their feelings about velar closure 20 years later, for Grabb et al. in 1971. They looked to adequate lip closure for its molding effect and expressed no great concern for "collapse" of the alveolar arch, because with growth this can be overcome. They had no interest in putting bone in the cleft where growth has merely begun to express itself. They felt that undue surgical interference could alter growth and appliances could act to constrict the maxillary segments or impinge upon the palatal shelves. At 12 to 24 months, velar closure was done simply in three layers after cleft edge paring; it can be done in two stages if necessary. They emphasized:

The principal feature of this velar procedure is to establish normal balance of muscle tensions across a defect. Surgical closure of the velum does more than repair a complete congenital defect; it provides a more normal physiological environment in which growth and development may take place.

Lip and velar closure was followed by a reduction in the width of the hard palate cleft. If it was narrow enough for minimal undermining of edges and direct closure, then this was justified. If by 2 years of age the cleft was still too wide, a plastic obturator was "snapped" into position for temporary aid.

In 1961 Luiz A. M. C. Madeira of São Paulo stated his endorsement of the Slaughter plan:

Closure of the soft palate at 18 months and of the hard palate after 6 years of age.
In 1966, in the *Journal of the South African Logopedic Society*, Dennis H. Walker advocated the Slaughter principle of lip and soft palate closure. Walker became James B. Cuthbert's first registrar soon after Cuthbert migrated from Rooksdown House in England and worked with him all 16 years of his life in Johannesburg, eventually being appointed to follow his chief as head of Plastic Surgery at the University of Witwatersrand. Adhering to the Gillies principle “Never do today what can honourably be put off until tomorrow,” and with respect for growth centers but anxious to harness molding forces of the “mouth muscle ring and palatopharyngeal muscle ring,” he closed the lip and soft palate only, except when a vomer flap was feasible. He noted the gradual change in the residual cleft, “the form of a long, narrow ellipse replacing the shorter, wider oval.” His orthodontist was able to promote quite satisfactory speech with an obturator altered frequently. Under this regimen, the residual hard palate cleft was left until 12 or 14 years of age, when the closure was relatively easy.

It is of interest that 10 years before Slaughter proposed velar closure, Hermann Schweckendiek, an otorhinolaryngologist of Marburg/Lahn, Germany, in 1944 proposed early closure of the soft palate through small incisions which did not necessitate mucoperiosteal dissections or osteotomy or ostectomy of the hamulus. He left the hard palate open and undisturbed, but occluded with a “speech plate” as late as 12 or 15 years. Gradual
closure of the bony cleft was noted from 15 mm. to 2 or 3 mm. and accompanied by a minimum of orthopedic disturbances. In the early 1960's his son, Wolfram Schweckendiek, continued to promote this principle.

Free development of the jaw and palate can be attained if the soft palate is closed during infancy by primary veloplasty, leaving a residual cleft in the hard palate. The cleft narrows spontaneously due to the growth of the sides of the palate, without causing any compression of the jaw.

The edges of the soft palate cleft were pared and side pouches dissected. A rubber band was passed with a special needle through the pouches and tamponaded by little foam rubber sponges in the pouches. The soft palate was united with three-layer suturing and the tension of the rubber band adjusted and sutured.

At the 1964 Hamburg Symposium the young Schweckendiek stated:

This procedure usually results in a primary union of the soft palate. The muscle layer develops well and the palate grows long and mobile. . . . The majority of the children acquire perfectly normal speech even though a small cleft remains. Other require a temporary plate to cover the cleft so that the spontaneous growth of the upper jaw may remain undisturbed for as long as possible. In case of total cleft, a correction of the position of the teeth in the area of the cleft is often necessary. During this treatment the residual cleft is covered by a plate.

The Schweckendieks prefer to operate on the soft palate at 7 to 8 months of age. In the complete cleft, the soft palate is closed first, and three weeks later the lip is closed, all at about 7 months. In cases of shortness of the velum, they use a superiorly based
pharyngeal flap. A plate is fitted, and closure of the residual cleft of the hard palate is postponed to the age of 12 to 14 years, when the normal growth of the jaw is virtually complete.

In 1977 at the Third International Congress on Cleft Palate in Toronto, Wolfram Schweckendiek reported 25-year results of normal maxillary and cranial growth, with 60 to 70 percent of the hard palate clefts narrowing and 95 percent of the alveolar edges approximating. Schweckendiek admitted to having some difficulty with speech development between 2 and 5 years of age but reported continued improvement after school age resulting in normal speech in 57 percent and minor problems in 37 percent; 5 percent of his cases required posterior pharyngeal flaps.

In 1964 Professor Burian in Hamburg briefly reviewed his palatal retropositioning and pharyngofixation carried out at age 5 years, which he had used for 40 years. He then informed the Symposium that he had changed to the Schweckendiek method. In the more formal third Gillies Memorial Lecture in 1964, Burian elaborated, recalling his earlier plan of lip closure at 5 months and palate at 5 years:

The patient has to be rehabilitated from the time of the lip operation till the operation of the palate. . . . The treatment lasted a long time and was also expensive. To reduce the sufferings of the patients and the distress of their families . . . I adopted, some years ago, the method of Schweckendiek which consists of the reconstruction at the age of 6 to 8 months of the soft palate alone. The cleft lip, in total, is operated on at the same time or some weeks later. To the hard palate, an occlusive plate is applied. The early construction of the soft palate reduces considerably the frequency of middle ear inflammations, both acute and chronic. The child acquires good speech quite quickly. The cleft in the hard palate narrows visibly and may be closed by an operation later on at any time. This is then a minor affair. The orthodontic treatment is very easy. . . . The Schweckendiek method seems to me to make the primary bone-grafting unnecessary and I hope that it will reduce considerably the need for secondary bone-grafting.

Čupar of Yugoslavia approved of the two-staged operations suggested by Slaughter and Schweckendiek as a really rational procedure. Early soft palate closure creates a more favorable basis for speech development and also avoids maxillary deformities. After lip and soft palate closure there is objective evidence that
the cleft in the hard palate is reduced. Later closure of the hard palate offers less chance of arch distortion.

PRIORIT Y

Regional loyalties and language barriers often dictate the name associated with an operation. In Europe Schweckendiek gets credit, but in the United States Wayne Slaughter's name is synonymous with the primary velar closure principle. At the 1969 International Cleft Lip and Palate Symposium in Chicago Slaughter was challenged. He cleared the air with one thrust and no parry:

That procedure was documented in 1840 and it has been referred to repeatedly. The last written reports were in 1914 by the late John Staige Davis and I had the privilege of seeing him perform some of these procedures before he died.

There had been sporadic expressions of conservatism from time to time. Even Dorrance in 1933 wrote:

The safest age to operate for cleft palate is about the fifth year of life. In our experience operations performed after the fifth year are free of mortality and failures are less frequent.

In 1972 Gustave Aufricht wrote:

I was and I am also against the early closure of the hard palate. Already, Esser advocated only soft palate closure and obturator for the hard palate until patient was fully developed.

The Schweckendieks and Slaughter, heeding the moaning and groaning of the dentists facing the dental disasters following the early traumatic palatal surgery, led a conservative revolution. This new stand stimulated research to try to determine what effects, if any, modern types of cleft palate surgery would have on young growing maxillary bone.

HERFERT

In 1958 Herfert, following his work on retardation of maxillary growth after mucoperiosteal dissection and vessel ligation in puppies, designed and timed his surgery in sympathy with his
research findings and according to the principles set by Schweckendiek and Slaughter. In 1963 he reported that since 1955 he had been using Schweckendiek's method. He did not feel, he said, that McNeil "stimulation plates" were necessary in cleft palate children, but he did recognize the importance of providing the infant with an intact velum with which to acquire normal speech and thus closed the soft palate only at 14 to 16 months. He noted:

After closure of the soft palate, contraction of its muscle fibers stimulates growth of bony palatal plates, especially to the periosteum near the rim. This functional stimulation of the periosteum leads to a true growth of bone which was noted in all our cases. Two, three or four years after closure of the velum, the cleft of the hard palate was reduced without any direct operative procedure. . . . By the two-stage operation of the cleft palate, two significant advantages are gained: normal speech is encouraged by early closure of the soft palate . . . and restriction of growth of the upper jaw is avoided, as the hard palate remains untouched. The second stage operation in the hard palate around 5 years of age becomes a relatively small procedure and is performed in ten to fifteen minutes.

CONFLICTING FINDINGS IN ANIMALS

Yet Sarnat, also in 1958, working on monkeys, excised the mucoperiosteal flap and ligated the greater palatine artery. In one group of animals he went "ape" and also excised the bony palatal shelf and nasal lining. These experiments showed no significant gross differences in growth and development of the hard palate, maxillary arch, mandibular arch, maxillomandibular relationship or total face. The implication is that neither the surgical trauma of raising flaps nor deprivation of blood supply is the cause of maxillary and facial lack of growth, a finding in accordance with Foster's 1962 work in humans with complete alveolar clefts.

In 1967 Kremenak et al. showed in puppies that unilateral excision of a 4 mm. wide strip of mucoperiosteum just medial to the posterior teeth caused a very definite decrease of palatal width (27 percent narrower) on that side. In contrast, elevation of a unilateral mucoperiosteal flap or ligation of the palatine artery caused only a 3 percent narrowing of the palate.
Maisels noted that these research contradictions would have thrown a confusing cloud over the decision for timing closure of the hard palate except for the 1966 findings of Latham and Burston. In the human, they showed that the lateral activity in the mid-palatine suture is greatly diminished by 18 months and has, for practical purposes, ceased by 2 years of age. Thus, after 18 months to 2 years, lateral growth of the hard palate takes place as a result of alveolar appositional growth only, and not by separation of the parts along the mid-palatine suture. Consequently, Maisels reasoned that operations on the hard palate at this time could not be expected to inhibit growth by tethering the two sides to each other by a sheet of scar.

Maisels breathed a sigh of relief at the convenience of these findings. British surgeons have long felt that the timing of closure of the secondary palate should be dictated by the need for acquiring normal speech rather than by fear of interfering with subsequent growth.

**DELAYING PALATE SURGERY**

Jack Longacre of the University of Cincinnati noted:

Growth studies have shown that the premaxillary suture closes at the end of the first year, but the sagittal suture separating the maxillae and the two horizontal plates of the palatine bone only closes between the age of four to five. This means that the transverse diameter of the bony palate and the arch is completed at this time. To this must be added the appositional growth on the surface of the bone.

He cited Logan Leven, who had shown that prior to closure of the defect the growth of the maxilla in the cleft palate group was nearly normal, but after closure of the defect there was marked retardation of growth.

Longacre therefore began playing a waiting game, and in 1964 in Hamburg he reported longitudinal results of his delaying policy:

We found that the group where the palate was repaired at or near the time of the closure of the sagittal suture (4 to 5 years) showed more normal facial development and less dental crippling than the other group.
He also noted that even in the older group, when the defect was large, there was some crossbite although to a lesser degree. Thus he proposed that his split rib grafts be interposed between the palatal shelves and the alveolar process to prevent even this amount of deformity. X-ray films taken in the area of the alveolar defect showed tooth buds growing down into the newly grafted bone, allowing for more normal eruption of the teeth.

Finally, in his 1970 book, *Cleft Palate Deformation*, Longacre presented his impression after 22 years with 500 cases. These had been corrected by himself with his modification of the LeMesurier-Hagedorn lip technique at 3 months and closure of the cleft palate by the V-Y procedure of Kilner-Wardill-Veau II. The only variable in the series was the timing of the palate surgery.

Longacre presented his findings with photographs of 24 patients, 11 with early palate repair (1 1/2 to 2 years) with poor results and 13 with late repair (3 to 4 1/4 years) with good results, showing less interference with facial growth, less retraction of the premaxilla, minimal collapse of the maxillary segments, more nearly normal maxillary arches, less septal deviation, better occlusion and fewer dental caries. Longacre said:

> It would appear from this study that these series had been operated upon by two different surgeons. More correctly, the difference in results may be correlated with the fact that the development of the maxillary arch is essentially completed (85%) by four years of age.

In fact, Jack Longacre often emphasized:

Comparing results in young adults between a patient with early palate repair and one with palate repaired at four years is almost like comparing Dr. Jekyll and Mr. Hyde.

The greatest criticism of waiting to close the palate for five and one-half years is the probable deleterious effect on the development of speech. In his defense, Longacre summarized the findings of Drexler, his speech pathologist:

> There is no significant difference in nasality, nasal emission and speech proficiency between the different groups. A similar . . . audiometric study failed to show any difference in the two groups with regard to hearing loss.
RITTER

Professor Reinhold Ritter of Heidelberg, Germany, argued:

If the total cleft palate is operated on before there is a good occlusion in the baby molar region (age 1–2 years) the result is always a bilateral, mostly asymmetrical or unilateral compression of the upper jaw. We see a cross-bite in the side-parts and there is a prognathism or opistognathia. . . . In early operation, the upper jaw and the cavum of the nose are often deprived and the teeth carious because they have no normal function.

He also noted that the children do not speak as well as those without deformity. At the 1964 Hamburg Symposium he discussed patients operated on at 5 years of age with normal occlusion who required only orthodontics for oblique front teeth. He explained his reasoning:

At age 5, the bone of the upper jaw is harder and scar has less chance of causing deformities.

In 1971 Ritter wrote to me to affirm his stand:

I have been interested in the treatment of cleft lip and palate patients since 1928, both orthodontic and surgical treatment. I believe that I was the first doctor who warned of early operations of the cleft palate because of disturbance of upper jaw growth. The best age for operation of the cleft palate is 5 years. The bone is hard enough at this time.

GABKA

The resonant Joachim Gabka of Berlin acknowledged his use of the Schweckendiek principle. He reported closing the lip at 6 to 7 months, the soft palate at 18 months, and the hard palate at 2 to 3 years. In his view construction of a velum at a relatively early age without deleterious influence on the growth of the upper jaw is important. Gabka’s studies in 1964 revealed that the most rapid narrowing of the cleft occurred within the first six months after primary velar closure and not later, as claimed by Schweckendiek.
LIMBERG

A most conservative surgeon as to age for palate surgery in modern times was the grand old gentleman of Russia, Alexander Limberg of Leningrad. He closed his lips at 1 year and occluded the palate cleft with a plate until the child was 10 years old, when he finally lengthened and closed the palate by his V-Y method.

DINGMAN

Reed Dingman of the University of Michigan, trained as both dentist and surgeon and with vast experience in clefts, has used many methods. At the 1973 Cleft Palate Congress in Copenhagen, with J. E. O'Connor, he reported his change to a conservative approach using a lip adhesion at 1 to 2 months and a definitive lip closure at 9 to 12 months. Then at 15 to 18 months he closes the soft palate, without undermining or incisions over bony portions of the palate, and at 2 years, after complete eruption of the primary molars, he inserts a dental splint to close the hard palate fistula. At 3 to 4 years a vomer flap is used to close the anterior cleft. He reported:

Results in speech and growth and development in these cases appear very favorable.

BLOCKSMA

Ralph Blocksma of Grand Rapids, Michigan, a plastic surgeon of Dutch descent, a dedicated missionary and a man of impeccable integrity, personifies to me the image of the ideal doctor. In 1974, before the American Association of Plastic Surgeons in Seattle with John Burnink, Christopher Leuz and Kent Mellerstig, he presented his conservative program for managing the oral cleft to eliminate radical mucoperiosteal flap procedures. A 10-year analysis of all cleft palate surgery performed at Butterworth Hospital for 1963–1973 revealed

Many patients who had had an early mucoperiosteal flap closure looked excellent at the age of 5 years, but exhibited evidence of serious maxillary
growth arrest at the age of 15 years. . . . Members of our clinic agreed that most of the deformities seen in patients with repaired cleft palates were fundamentally iatrogenic in origin, and we included:

1. The flat face syndrome (hypoplasia of the superior maxilla and a short nose)
2. The bad teeth syndrome (irregular dentition and dental caries)
3. The distorted arch syndrome (malocclusion, with a contracted superior dental arch)
4. The financial exhaustion syndrome (expenses for the hospital, pediatrician, orthodontist, prosthodontist, plastic surgeon, ENT surgeon, psychologist, and speech therapist)

Blocksma formulated the following laws of good palate surgery:

**Do Not:**
1. deprive the palate bone of any part of its blood supply
2. violate the vomer or deprive it of any part of its blood supply
3. amputate the premaxilla or prolabium
4. denude the entire hard palate to gain temporary length for the soft palate
5. simultaneously deprive the palate bone of both oral and nasal mucosa
6. sacrifice long-term growth for immediate surgical expedience

**Do:**
1. obey the laws of good wound healing
2. keep relaxing incisions small
3. delay surgery involving bone at least until after the fifth year

This conservative approach, started in 1964 and now used with all oral clefts, closed the lip at 3 to 4 months with minimal undermining. At 18 to 24 months, closure of the soft palate with a modified von Langenbeck technique involves a small S incision around the maxillary tuberosities with fracture of the hamulus, division of the posterior palatine aponeurosis from the margin of the hard palate and nasal and oral mucosa suturing.

Blocksma noted:

In most cases a virtually complete abutment of the cleft of the hard palate occurs spontaneously with growth. This is not always true. . . . At the age of 4 to 5 years, a simple turnover vomer flap will suffice to close the narrow hard palate fistula, after most of the palatal growth has been achieved. . . . We then determine whether a pharyngeal flap is indicated, whether speech therapy is needed, or whether a Teflon implantation into the posterior pharynx may be required.
In 1977 Jean Psaumé and René Malek of Paris advocated soft palate closure before closure of the lip and hard palate because tongue retroposition occurs on account of lack of normal soft palate and abnormal width between pterygoid processes. They predict that early soft palate closure will correct preoperative tongue retroposition by improving muscle balance.

**OPPOSITION**

In 1966 Friedrich Schröder of Würzburg favored the von Langenbeck-Ernst-Veau palate bridge flap method over the Schweckendiek method because

1. Deformation of the maxillae after Schweckendiek’s operation can be avoided only in narrow clefts.
2. Good function of the soft palate can be achieved only in favourable cases. Since correction of an insufficient soft palate after Schweckendiek’s veloplasty by pharyngoplasty is recommended not earlier than the second decennium, the most favourable period for speech development is thus missed.

In 1977 Ken Bzoch of the University of Florida warned:

The rationale for two-stage surgical closure (i.e., soft palate first followed later by hard palate closure with obturation of the hard palate before final closure) appears logical but presents many hazards to achieving normal speech. Its application is usually devastating to speech development whenever prolonged postponement of hard palate surgical closure is followed. Obturators generally result in an inadequate seal of the hard palate as the soft palate moves toward closure. My longest experience with this method of approach involved primary soft palate closure postponed to 18 months followed by hard palate closure between three and four years of age. An excellent prosthodontist prepared and modified hard palate obturators in the interim. The population receiving this approach presented with a large number of abnormal habits of articulation, particularly glottal stop substitutions. Although early direct speech therapy was able to modify this in many cases, they were not as successful as early complete closure patients with similar clefts today. I might add, I can see no reason from experience or research why soft palate closure could not be instituted as early as the timing of lip closure for the advantage of this on facial growth, eustachian tube function and for muscle hypertrophy. Complete hard palate closure might then follow between one and three years of age.
At the 1978 American Cleft Palate Association meeting, Bard Cosman and Arlene Falk of Columbia Presbyterian Medical Center, New York, reported on the speech results of approximately 35 patients treated with early closure of the soft palate and delayed closure of the hard palate at 6 or 7 years (Schwecken-diek). At age 6 years, 66 percent had poor speech and 32 percent had had secondary pharyngeal flaps. It was predicted that nearly 60 percent would eventually require a secondary pharyngeal flap.

**LIP ADHESION**

The lip adhesion principle developed by B. Johanson, R. Millard, P. Randall, J. Walker, R. Meijer and M. Collito has been described in detail in Volumes I and II. It is a simple surgical procedure available when presurgical orthodontics is unavailable to move maxillary segments into a more convenient, and possibly a better, alignment in preparation for definitive lip closure and eventual closure of the alveolar and hard palate cleft. By avoiding early elevation of mucoperiosteal flaps, it follows the same conservative principle of molding anteriorly what early soft palate closure achieves posteriorly. Often the two—lip adhesion and soft palate closure—can be carried out together, advantageously, at a very young age.

Since Volumes I and II of *Cleft Craft* have been published, a modification of the adhesion procedure has been developed. Cleft edge mucosal flap 1 is still used, but it is seldom inserted along the intercartilaginous line. Rather, the release of short, lateral vestibular mucosa is made by an incision running straight backward along the pyriform aperture. By letting 1 flap into this anteroposterior cut, the vestibular mucosal shortness is relieved without evertting the alar base and rim. Through this vestibular incision the nasal skin can be dissected from the alar cartilage. Then through-and-through lifting stitches can help slide the alar cartilage and its attached mucosa up into a better position. The lip is joined as a temporary adhesion using medial mucosa turned over to make up for any lateral defect left by 1 flap.
Richard F. Greminger of the Albany Medical College has extended the design of a flap to include a periosteal base (p), which, when approximated to a mucoperiosteal flap elevated from the alveolus, creates the inside lining of an "alveolar" ridge.
15. Nasal and Labial Flaps for Alveolar and Hard Palate Closure

The cleft of the alveolus and hard palate has been closed with various mucoperiosteal flaps turned off the vomer. This being a one-layer closure with a raw surface, there is some contracture resulting in varying degrees of maxillary distortion. The distortion depends on the position of the elements prior to surgery and the age of the patient at the time of surgery.

In 1872 Lannelongue closed the hard palate in a wide cleft by utilizing a portion of the vomerine mucoperiosteum which was continuous with one border of the defect. He made an incision on the vomer parallel with the border of the cleft, extended the anterior and posterior extremities of the incision to the border of the defect and elevated the vomerine mucoperiosteum from the underlying bone. The flap created was then held with sutures to the denuded palatal mucoperiosteum of the opposite side.

Other flaps from tissues of the nasal chambers have been used to close hard palate clefts. As early as 1851 Gay used a full-thickness flap of septum to fill the cleft, and in 1890 Sabatier moved the septum nasi to the horizontal plane of the palatal vault. Anton Freiherrn von Eiselsberg, in 1901, when he became director of the First Surgical Clinic of Vienna, reported using the vomer and its mucoperiosteum to close unilateral alveolar and hard palate clefts. Anyone tempted to repeat these maneuvers in a child should heed the words of Gillies:
The initial mistake was the opportune but ill-considered manoeuvre of bringing down into the palate defect in a wide unilateral cleft of the alveolus and palate a whole-thickness flap from the septum. The primary object of filling up rather than pulling together the gap in the palate was singularly successful to the extent of perfect speech. But his nose remained juvenile and flat, for the possible effect on the growing centres of the nose had been overlooked.

In 1895 Kraske used the inferior turbinates to close palatal clefts. He resected the inferior turbinate from before backward, leaving it attached behind but fracturing the bone in the pedicle as it was swung forward and sutured to one side of the denuded cleft in the palate. Fourteen days later the pedicle was divided and the remainder of the turbinate attached into the cleft. Kraske advised removing the bone when using this flap for cleft velum.

PICHLER

Hans Pichler, an Austrian who worked with Esser, was important in the development of maxillofacial surgery before World War I. He was an instructor of Richard Trauner of Graz, who recalled:

Pichler was a very true and upright man. We were united because of our great love of nature. Pichler fabricated ice sailing sledges on the large but narrow Lake Neusiedlersee near Vienna living there very spartanic but it was great fun for all when one of the pampered elder assistants slipped and fell into the ice water!

In 1926 Pichler first developed dissection of the cranially based vomer flap, which in unilateral clefts he tucked under the mucoperiosteum of the opposite edge of the palate cleft and fixed with mattress sutures to close the anterior hard palate in one layer.
In bilateral clefts he combined von Bardeleben’s retropositioning maneuver of the premaxilla with hard palate closure using two mucoperiosteal flaps from the vomer tucked under the cleft edges.

V E A U

Victor Veau was the world leader in clefts in Europe from about 1925 to 1945. In the late 20’s he had his own hospital with 75 beds where he treated his cleft lips and palates. Gerald O’Connor of San Francisco, who was training with Gillies in England, often crossed the Channel to observe Veau at work. He recalled:

Veau was a slow, meticulous innovator and rather stubborn—his way was the only way. He was a character, too, sitting in a “high baby chair” with a back, arm rests and feet support. He wore a baseball hat with magnifying glasses and had a large tube constantly passing oxygen under his shirt to keep the ether or chloroform fumes from putting him to sleep. His technique, surgery and judgement were quite good and basically he was a very good teacher and I would have learned and understood more had I spoken French.

Another version comes from Rudolf Meyer of Lausanne, who of course speaks French fluently. He recalled Veau sitting on a chair in the middle of the room waiting for the operating table bearing a cleft child to be rolled before him. As Meyer noted, he was

not unlike the famous clown Grock who used to be sitting on a small piano chair under a spotlight, waiting for the grand piano to be brought to him.
The sound surgical principle of closing raw areas was the basis for Veau’s greatest contribution. In 1931 he was turning vomerine flaps into the cleft to supply closure for the nasal side and partially reinforcing this with an oral mucoperiosteal flap. Previously, the nasal side had been left raw and subject to contracture and fistulae.

His method varied from that of Pichler in that the vomer flap did not tuck under the mucoperiosteum but was sutured to the freed nasal mucosa.

In 1937 Wardill republished Veau’s diagrams to describe his own approach to the anterior cleft. Kilner’s approach was also similar to Veau’s, employing a one-layer mucoperiosteal flap closure of the anterior palate alveolar cleft and usually accomplishing it at the time of lip closure because of the ease of exposure. When postponed until after the lip has been united and has pulled the alveolar segments into apposition, this procedure becomes an awkward maneuver. The width of some clefts in the alveolar area and the fear lest a one-layer closure distort the alveolar arch by contracture have been the factors causing some surgeons to procrastinate on alveolar treatment at lip closure time.

PREMAXILLARY FLAPS

In 1927 Franz Ernst of Berlin advocated eversion of the mucoperiosteum of the premaxilla in bilateral clefts from before backward. It could, he noted, be divided in the midline and
turned leaf-of-the-book-wise to fill the cleft on each side between the premaxilla and the maxillary bone.

**COE**

Dissatisfaction with the anterior nasal closure of bilateral clefts by the standard Veau method led Herbert E. Coe of the University of Washington School of Medicine, Seattle, to describe a turn-under flap of premaxillary mucoperiosteum. In 1953, in *Plastic and Reconstructive Surgery*, he diagramed the usual von Langenbeck procedure with closure of the palatal cleft up to the premaxilla. Then a turnback flap of mucoperiosteum from the premaxilla based on its posterior edge would be turned and tucked under the mucoperiosteal flaps at their anterior cleft closure and fixed with sutures.

**DUNN**

In 1952 Fred Dunn of New York City advocated the use of vomer flaps to close the hard palate cleft. In two later sessions, first the soft palate was closed as far forward as possible, and finally the remaining defect, by two narrow, bipedicle mucoperiosteal flaps. The entire process was usually complete by 4 years of age, and Dunn reported good results with no interference with bone growth, tooth eruptions in correct position, normal dental and palatal arches and flexible soft palate.

**STENSTRÖM**

About 10 years later, Stenström, intrigued by Dunn’s report, carried out 10 such operations but added his modification. In 1973 he began to make assessment of this approach.

Sten Stenström of Umeå University Hospital, Sweden, is a little man with a short temper, a big heart and the soul of a missionary. He is usually inaccessible, working in his retreat near Lapland, several hundred kilometers south of the north polar circle where reindeer roam in the midnight sun. Yet he has been known to venture forth in missionary expeditions to Abyssinia,
and I remember him at the Swedish Red Cross Hospital in Korea. In Copenhagen in 1973, at the Cleft Palate Congress, he presented his interesting use of skin grafts to cover the raw surface of vomer flaps.

The vomer flap was incised and elevated in the usual fashion, and a full-thickness skin graft from the hairless groin was buried in the pocket with the raw areas facing each other. Twelve days later the lined vomer flap was again released, turned over and tucked under the opposite edge of the palate cleft. Stenström reported that in four weeks the depression on the side of the vomer was mostly filled out. In 1974 with Thilander, in the Scandinavian Journal of Plastic and Reconstructive Surgery, he presented diagrams of his method used in unilateral and bilateral clefts.

His follow-up of these 10 cases showed occlusion to be perfect except in three, and, although the soft palate appeared short, only three required posterior pharyngeal flaps. Late in 1974 Stenström sent me this note and the accompanying, more modern diagrams:

The report I gave in Copenhagen has been borne out in every detail by our subsequent experience:

The skin-grafted area of the hard palate completely resembles the untouched palatal mucosa; the shapes of the palatal and dental arches are strikingly good and there is almost no constriction of the maxilla in a transverse direction. I have also found that the soft palate can be completely closed at the same time without bilateral relaxing incisions. The usual uneventful healing is in my opinion due to the exclusive use of figure-of-eight sutures. Only in the case of very wide clefts is it necessary to leave a small residual opening at the front of the soft palate for closure at a later stage.

In some cases split-skin grafts were tried for covering the "vomer-pocket" instead of full-thickness skin grafts. Although I have not yet seen any bad effects from this, I have nevertheless reverted to full-thickness skin grafts in
order to eliminate as much as possible any tendency to shrink. A. Unilateral
cleft. B. Vomer flap being tucked under opposite edge. C. Soft palate closure
obtained without relaxing incisions but with figure-of-eight mattress sutures
of 4-0 polyethylene. D. Full-thickness skin graft sutured along medial and
lateral cleft edges. E. The vomer-pocket has been filled out with Visco-gel
(De Trey). F. An acrylic palate plate has been placed on top of the Visco-gel
and fixed with transpalveolar sutures.

In 1978 Gunnar Jonsson and Sten Stenström of the University
of Umeå, Sweden, presented further confirmation of this ap­
proach. They studied 6 to 8 week old beagle puppies in which the
hard palate bone and the covering oral mucoperiosteum had been
removed, except for a 4 mm. wide strip of bone in the midline.
On one side the nasal mucoperiosteum was covered with an
autogenous full-thickness skin graft (SGS) while the other side
was left raw (RS). At 47 to 52 weeks of age the dogs were
sacrificed.

The palatine suture was displaced towards side RS on all dogs, and the
height of the nose was in all dogs greater on side SGS. There was a small
consistent tendency that the overall growth was more pronounced on the
side with the full-thickness skin graft. It is concluded that reducing the
amount of scar tissue by covering raw surfaces with an autogenous full-
thickness skin graft is one way to reduce maxillary growth impairment after
palatal surgery.

In what could possibly be interpreted as an indirect, partial
endorsement of his Swedish colleague’s effort to cover the raw
surface of the vomerine flap, Johanson, with Hans Friede of
Göteborg, wrote in 1977:

The development of the face and jaws in cleft patients, treated with a
three-stage surgical procedure including a single layer vomer flap, was
studied by analysing cephalometric radiographs and dental casts. The
material consisted of 13 patients with complete bilateral cleft lip and palate and 50 cases with complete unilateral cleft lip and palate, operated on 1964-1970. At the follow-up the average patient in both cleft categories demonstrated a maxillary retrognathia and in the unilateral cleft sample also a facial skeletal profile straighter than normal, though not as pronounced as we had found in cases where the vomer flap procedure was accompanied by bone grafting. However, the mean profile for the bilateral as well as the unilateral cleft group was straighter than reported for patients subjected to neither vomer flap nor bone grafting. The occlusal findings confirmed the maxillary growth retardation. . . . In an effort to reduce the restricted mid-facial growth found in the present patients, we have changed our surgical technique and since 1975 exclude the use of vomer flaps.

NEED FOR TWO-LAYER CLOSURE

The classic lip closure is done at about 3 months of age. When the clefts of the alveolus and anterior palate are closed at the same time with one-layer closure, faulty molding of the maxillary segment not infrequently results, with the premaxilla impinging on the collapsed lateral segments. Thus, surgeons have devised methods of accomplishing a two-layer closure of the anterior palate cleft.

CAMPBELL

Andrew Campbell of Johannesburg, South Africa, in 1926 tried closure of the alveolar and hard palate cleft with a septal flap, but the cartilage became detached and he then modified his plan and designed a two-stage closure. One flap took mucoperiosteum from the septum with the base on the palate; the other took mucoperiosteum from the cleft side of the palate based toward the nose. These flaps were overlapped across the cleft, bringing raw surface to raw surface with a broad plane of union and leaving no raw area in the mouth or nasal floor and no reason for contracture.
As Campbell said:

So far we have found that the raw surface on the septum is of little consequence. . . . There is no tendency to sloughing of the septal cartilage, and this is not surprising because of the excellent blood-supply from the opposite side. . . . If one deals with a bilateral cleft, the same operation is done on the other side but it is wise to wait until the raw surface on the septum is entirely healed—from four to six weeks.

This principle is the basis of several modern German and American anterior cleft closures.

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**BURIAN**

In 1955 at the International Congress in Stockholm, Professor Francis Burian of Charles University, Prague, Czechoslovakia, described an upper buccal sulcus flap to aid in the two-layer closure of the alveolar cleft. He stated:

Severe cases of cleft-lip ought to be operated on later than lesser ones, the more so if greater deficiencies are present. The earliest date ought to be the fourth month of life.

His ideas after 30 years and 3,000 cases are of interest:

With severe cases of complete cleft it is not advisable to bring the poles of the cleft together. On the contrary, prevention of contact seems to be indicated. In 1933 I started to put a flap of lip mucosa between the poles of the cleft as a covering for the oral aspect of the reconstructed floor of the nostril. It was designed at that time as a method of preventing perforations in the anterior part of the palate which were of frequent occurrence in the Veau operation. I dropped this interposition-operation after discussion with Veau, who considered the gap in the alveolar process as an imperfection much worse than a naso-buccal communication. Later on when observing the operated patients I was impressed that on those operated by the interposition method, . . . there was much less deformation, . . . except for the premolar segment of the jaw. . . . [Thus] I resumed a modified interposition method with severe total clefts . . . omitting the formation of the palatinal flap and inserting the vomerian flap as advised by Campbell.
In 1976, M. Hotz of Zurich noted:

However, alveolar closure with Burian flaps (consisting of a small mucoperiosteal flap and a larger vestibular mucosal flap) at the time of lip closure seems to affect canine position. Burian flaps were utilized in about half of the present cases of unilateral as well as bilateral clefts. Each one of these patients shows a canine cross-bite. Therefore, this particular variation of procedure was abandoned a few years ago.

STEMLACH

In 1959 the astute Rudolf Stellmach of Berlin, considering mucosa from the upper lip inadequate for closure of the oral layer of the alveolar defect, developed a vomerine flap based anteriorly. This flap was turned 180 degrees to achieve oral closure for the usual nasal flap and an intervening bone graft.

In 1977 Stellmach reminisced:

Around the mid-fifties when we began to bonegraft the alveolar gap primarily in total clefts, we used a flap of lip mucosa for covering the oral aspect of the implanted bone. Flaps of this type, aimed at safe double layer closure of the postalveolar region, were described before by Burian (flap pedicle medial) and by Trauner (flap pedicle lateral). In using this with bone grafting I often found the vestibulum lining diminished, causing some inward traction of the lip. As we had discontinued closure of the hard palate, this brought me to the idea of covering the bone graft with vomer lining from behind. The vomer flap has an ideal quality for this purpose as it is thick and contains periosteum. When incised high at its cranial base
from back to front it can be turned forward. A pouch is created within the alveolars which can be filled up by bone chips. Shortcomings from lack of lip mucosa could be prevented.

**STEINHARDT**

Gerhardt Steinhardt of the University of Erlangen-Nürnberg, Germany, in his 1973 book with Schuchardt and Schwenzer showed again his method of two-layer closure of the alveolar defect. He employed a Pichler-type vomer flap for nasal closure and then cut a rather radical alveolar mucoperiosteal flap based above which he used to overlap his nasal closure as a second layer.

**MIUR’S MUCOSAL FLAP**

Ian F. K. Muir, a discerning Scotsman, is consultant in Aberdeen. While at Mount Vernon Centre for Plastic Surgery, England, he made several interesting observations and proposed an ingenious solution to the problem of the raw area in the alveolar closure. In the January 1966 *British Journal of Plastic Surgery*, Muir noted that in some babies with unilateral complete clefts the maxillary segments are in good alignment, and, after standard lip and anterior palate closure, end-to-end abutment of the alveolar segments occurs with good arch shape and dental occlusion.

In other newborn babies the premaxillary portion of the non-cleft segment is rotated away from the cleft, and subsequent medial movement of the lesser segment brings it in behind the premaxilla so that the arch is more triangular than the normal
horseshoe shape. The cause of this collapse has been attributed to the tension of lip closure. Muir analyzed the circumstances and laid the blame elsewhere:

The cleft in the alveolar gap . . . is usually closed by a single nasal layer leaving, on the buccal aspect, a raw surface . . . up to 1 cm. wide . . . [which] is . . . left to granulate, and finally to heal by secondary epithelialisation. This process takes place rapidly (although sometimes a breakdown occurs and a fistula is left), but must inevitably be accompanied by the formation of scar tissue . . . [and] results in the rapid in-drawing of the lesser alveolar segment.

In a complete cleft of the lip and palate there is a raw area left during a standard closure, as the Veau flap will not reach forward between the alveolar ends. Muir concluded that if the raw area could be eliminated its harmful effects would be minimized. He then proposed a flap for this purpose that could be better spared than the Burian buccal flap. True to the frugal Scots character, he noted:

There is, however, a source of tissue which appears not to have been tapped, namely the mucosa of the free edge of the lip which is usually discarded at operation. This tissue can be retained and used as a soft tissue flap to provide a buccal layer for the repair of the alveolar cleft. In practice the tissue from the lateral edge of the cleft lip has proved most suitable. This tissue can be dissected up to a narrow base on the buccal aspect of the lip, and turned back into the cleft where it can be held by two “A” stitches.

Muir reported no fistulae and no alveolar collapse following this technique. Yet the presence of a lined gap in the alveolar area
presented two problems. There was some difficulty in hard palate closure across a persistently wider cleft, and some patients showed a substantial deficit of alveolar bone. With both cover and lining available, Muir proposed combining closure of the lip with rib bone grafting to the alveolar area.

Since the use of his flap was originally incorporated in a Tennison lip design, it was hoped that by 1974 he would have changed to the rotation-advancement approach and indeed he had! He kindly sent me more modern diagrams showing his flap during a rotation-advancement lip operation achieving a two-layer alveolar closure.

D. H. Walker of Johannesburg, reveling in freedom because, as he said, "consistency is a virtue of small minds," devised another variation of the two-layer closure of the "gap in the gum."
OVERLAPPING THE ANTERIOR FLAP CLOSURE

Nobuhiko Isshiki and Masanori Morimoto of the Otorhinolaryngology Department of Kyoto University designed a reinforcement of the anterior nasal closure of unilateral clefts, reported in 1968 in *Plastic and Reconstructive Surgery*. The V-Y mucoperiosteal flaps were cut narrower than those designed by Ganzer, Ernst, Veau, Wardill or Kilner. Then a wider mucosal flap was freed from the vomer on one side and the standard flap from the hard palate on the other, presenting enough excess for an overlap anteriorly. The mucosa of the flap on the vomer side was shaved raw for adhesion in the overlapping, which was fixed with sutures. The V-Y mucoperiosteal flaps covered the posterior area, and a labial mucosal flap covered the anterior extent of the cleft.

The development of various two-layer closures of the alveolar defect was destined to be of inestimable value during the alveolar bone grafting era.

It is interesting that two relatively new principles in the early treatment of alveolar clefts, *presurgical orthodontics* and *free bone grafting*, were evolved in different centers at about the same time and eventually were adopted for use in conjunction with each other in many more centers. As orthodontic manipulation was originally designed to aid the surgery by positioning the maxillary segments for bone graft stabilization, this aspect will be presented first.
16. Presurgical Maxillary Orthopedics

As explained by Clodius in 1964:

Maxillary orthopedics, . . . in contrast to orthodontics, are essentially the movement of basal bone, its alveolar process and the dental units contained within. If the teeth have erupted, they serve merely to enhance anchorage for orthopedic movement.

In 1772 Levret of Paris was the first to appreciate the orthodontic significance of additional extraoral force. He employed a linen band, not only to protect the suture line but also to align the maxillary arch.

In 1790 Desault, likewise of Paris and often considered the father of presurgical maxillary orthopedics, using a linen band tied tightly over the projecting premaxilla and around the neck in a "dental arcade," preoperatively reduced a 12 mm. protruding premaxilla in a 5-year-old girl, bringing the prolabium on a level with the lateral lip elements.

Eight years after the publication of Desault's collected works, Lefoulon in Paris expanded the maxillary arch of a young English professional singer with an anterior lingual spring. He introduced the term *dental orthopedics*—this part of the dental art being necessary to cure congenital and acquired deformities of the teeth and their arches.

In 1892 Friedrich von Esmarch designed an elastic band attached to a headcap. Its purpose was to keep the premaxillary segment in place after it was retropositioned by vomerine section. As Clodius points out, the von Esmarch design is widely used by many modern surgeons throughout the world, including himself.
but as a presurgical orthopedic maneuver to avoid vomer sectioning.

McNEIL

The concept of early orthodontic treatment in alveolar clefts was introduced by C. Kerr McNeil of the University of Glasgow in 1950. There were two facets to his original concept:

1. The diminution in width of the palatal cleft brought about by the stimulation to growth of the palatal shelves under the influence of an oral appliance designed to promote such growth.
2. The control and correction of the displaced maxillary segments seen in clefts of the lip, alveolus and palate prior to surgery, thus assisting the surgeon by presenting him with a more normal bony facial skeleton over which he could perform his repair of the soft tissues.

McNeil advised cutting the model of the upper arch in an antero-posterior direction and shifting the two sections to partially correct the deformity. He then made an appliance to fit the corrected model, which the baby wore until need for a new appliance developed every few weeks. Outriggers on the appliance were attached to a cloth headcap. The plate was retained until after the palate repair. Elastic pressure was used against the projecting premaxilla.

Thus McNeil, the Scotsman, had started a movement of early orthodontic manipulation which was destined to be adopted in units around the world. The concept caused thought, trial and frustration, leading eventually to modifications to fit the facilities available in the specific areas.

BURSTON

In 1955, in response to a request by the plastic surgeons of Liverpool, William R. Burston of the School of Dentistry, University of Liverpool, undertook a pilot study of the McNeil approach. By 1958 the method had been adopted as a routine. In 1965, after 10 years of experience, Burston wrote:

Whenever and whatever orthodontic treatment be given to a case of cleft lip and palate, it is the surgeon who will mainly determine the eventual
result. . . Early orthodontic treatment of the infant makes its contribution by helping the surgeon to achieve a good primary repair of the lip over a symmetrical and well balanced facial skeleton. If this can be achieved, later orthodontic treatment becomes much more practicable.

In the same year, Burston outlined the method originally advocated by McNeil and being used by himself:

A feeding plate is inserted as soon as possible after birth, preferably before the infant has its first feed; this is a simple plate without bite blocks and can be provided within a few hours of taking the first impression. . . . When early orthodontic correction is judged necessary, a correction plate is fitted which incorporates bite blocks. The bite registration is a very important step in the technique because much of the action of the plate is derived from the child chewing into the plate. The blocks must be high enough to gag the bite and produce reflex chewing. The height is correct when there is a forward pressure on the plate (as shown by the blanching of the mucosa seen through the clear acrylic) during the biting and yet the plate is not dislodged. The time to change or alter the plate is reached when a uniform blanching occurs on chewing. Extra-oral strapping is employed to assist the action of the plate. . . .

The usual pattern in a thriving infant is that most of the improvement occurs within four months and that only in exceptional circumstances is further delay in lip repair justified.

In unilateral cases, provided good arch alignment has been obtained, the anterior palate is closed at lip operation. If, however, there is a significant gap between the alveolar segments, lip repair only is undertaken and an attempt made to improve the defect before the palate operation. Should this attempt fail, the soft palate and posterior half of the hard palate only is repaired and the residual defect closed by a bone graft inserted at age 3-4 years.

In bilateral cases, experience suggests that it is wise to close the anterior palate in most instances, even where orthodontic treatment has been only partially successful.
Burston warns that, following lip closure, most children should continue to wear a plate until the time of palate closure, with benefit to arch alignment, to feeding and to possible reduction in the width of the cleft. In a bilateral condition, if the anterior clefts are open without a plate, there is a real risk that the premaxilla will grow forward out of alignment, as shown here after an 18-month period. Explained Burston:

Early bone grafting has not been practiced in Liverpool because of the dangers of fixing the segments in an arbitrary and possibly unfavourable position.

By 1971 Bill Burston, a tireless, dedicated worker, consultant orthodontist and honorary lecturer in child health, had set up two baby cleft units, one at Alder Hey Children's Hospital and the other at Heswall Children's Hospital, the whole setup consisting of cots for 23 babies, plus accommodations for four mothers who may wish to be in with the babies. In 1977 he reviewed the principles of presurgical orthodontic correction of the maxillary bones in total clefts.

1. The deformation of the maxillary and premaxillary bones is brought about by separation of one or both sides of the maxilla from the nasal septum. In the unilateral case, there will be deviation of the midline to the non-affected side; in the bilateral condition the premaxilla remains on the vertical tip of the septum; i.e., the patient has a snout like any other animal. The nose of man is unique.

2. The facial sutures are open and active in the neonate and are thus capable of responding to the force applied to the bones. Growth of the face is very rapid in the first few months of post-natal life.

3. Force may be applied by fitting a plate which has been deliberately "corrected" and which also gags the bite slightly to promote chewing activity. Models are presented to chart the progress in a unilateral and a bilateral case. A. Plaster cast of the maxillary arch at birth. B. Corrected cast. C. Corrected cast with plaster added to relieve pressure on
growing margin of bones. D. Wax preform of plate to determine vertical height of bite blocks so as to gag the bite. E. Finished plate. F. Cast of corrected arch. This action may be reinforced by extra-oral pressure via an elastic strap with a pressure pad, the strapping being applied to a base of micropore tape stuck on the face.

4. The plate obturates the palate defect and this assists feeding. By denying the tongue access to the cleft, the latter closes down markedly, thus helping palate repair. The treatment involves fitting a succession of plates, taking about four plates for full correction of the segments.

This aid to surgery has a natural appeal to surgeons. In 1962 G. Crikelaïr, A. Bom, J. Luban and M. Moss of Columbia University, New York, reported six patients with complete unilateral cleft of the lip and palate treated by a modification of the McNeil principle, an acrylic intraoral appliance being used prior to surgery. They noted:

The opening in the hard palate decreases to a great degree spontaneously and in one patient disappeared completely.
It will not be obvious at first sight which do not need it, but it will do no harm and as soon as relationships are seen to be satisfactory, lip surgery is indicated.

As pointed out by Maisels, some cases respond to orthodontics better than others and by 3 to 4 months are ready for surgery. Some do not respond favorably and at 6 months are still not correct. In these patients the lip is closed, the anterior palate left open. Reexpansion of the arch at 5 years is stabilized with a bone graft.

In bilateral clefts, sufficient alignment has been achieved at 3 to 4 months to allow lip and anterior palate closure (A). Maisels warns that closing the lip but failing to close the anterior palate may not restrain the central stem (B).

In a small group, presurgical orthodontics fails to control protrusion of the premaxilla, and surgical retroposition becomes necessary. In Liverpool, this group constitutes 6 out of 76 bilateral cases.
In 1974, in the *British Journal of Orthodontics*, Maisels, from his enviable position of having had excellent presurgical orthodontics available for years, verbalized with clarity what most surgeons feel:

It is axiomatic that for any one surgeon, the easier the operation, the better will be the final result.

Here are two of Maisels’ cases, a unilateral and a bilateral cleft lip and palate, presented to emphasize the value to the surgeon and the patient of presurgical orthodontics.

Maisels stated:

Few would disagree that the technical difficulties of repairing this cleft have been greatly simplified in two ways. In the first place, the actual cleft is considerably narrower and the nasal deformity reduced following treatment, but what is perhaps just as important is the reduction in the degree of distortion. . . . In order to achieve closure of a very wide cleft lip, considerable dissection is required to free the soft tissue from the maxilla. Opinions differ as to whether this is best done superficial or deep to the perios­teum lest the subsequent growth of the maxilla be jeopardized. This
difference of opinion is perhaps an indication that neither technique, if performed with care and precision, will have an adverse effect. However . . . there is no doubt that the pre-treated cleft will require less freeing of the tissue to close the lip without tension.

Whenever possible, the lip repair is combined with repair of the anterior palate although there have been instances when the orthodontist has requested the omission of this stage. . . . This practice is becoming less common as we move to the view that any post-operative correction is probably better carried out later by rapid expansion and bone grafting (Matthews and Grossman, 1964).

Here is another example of a unilateral case treated by Burston with presurgical orthopedics, which eased the strain on Maisels when he carried out the rotation-advancement lip and nose correction.

Maisels cautions that it is necessary to give the orthodontist time to prepare the patient:

In practice, we have found in Liverpool that the average case is repaired at 6 months although [this] shows a baby with a fairly severe bilateral deformity who was ready for operation at 3 months. In bilateral cases both sides are repaired at the one operation.
Such orthodontia is like manna from heaven to a surgeon sitting down to close a severe bilateral cleft lip. Yet heaven does not rain "manna" equally upon all surgeons. Presurgical orthodontics certainly facilitated the first-stage lip closure of this bilateral cleft. Maisels elaborated:

Probably the greatest influence of presurgical treatment has been the elimination of the need for excision or recession of the protruding premaxilla in severe bilateral clefts (Browne, 1949; Cronin, 1957; Monroe, 1965). Not only is it possible to correct the forward protrusion and upward rotation of the premaxilla . . . but also any lateral rotational deformity can be adjusted . . .

I now carry out a simple repair of both lip clefts and anterior palates at the primary operation, preserving virtually all the soft tissue in the lip. Then when the baby is 2 to 3 years of age, the columella is lengthened by a forked flap, as described by Millard (1958).

Here are two examples of the Burston presurgical orthopedics followed by one-stage lip closure and later forked flap by Maisels, sent to me in 1976. At this time Maisels wrote me that Burston had suffered a most frightful burn but was back at work with his nose and forehead reconstructed by flaps and his left eye blanked out by a deltopectoral flap. Despite this handicap he gets along well, not only with the children, but with the parents, because, of course, "it is still the same old Bill underneath."
JOHANSON'S ADVANTAGE

It is likely that most cleft surgeons would welcome presurgical orthopedics if it were available. As early as 1956 in Stockholm, Bengt Johanson was receiving this benefit. K.-E. Nordin was achieving arch alignment with a plate provided with a coffin spring and a little screen resting on a premaxilla and exerting pressure in a backward direction when expansion was in progress. This work was used in preparation for Bengt Johanson's early primary bone grafting. Later, in 1964, orthodontists Åke Ohlsson and Anna Kling reported the orthopedic method used in Göteborg, Sweden, in cooperation with surgery by B. Johanson. At age 1 to 2 months the nasal floor was closed, and 10 days later a plate was inserted. The plate was provided with facial arms for fixation with tape. In unilateral cases with contraction, a screw plate was used and the position of the screw varied according to the deformity and the effect desired.

In bilateral cases, expansion treatment again began 10 days after closure of the nasal floors. The divided screw plate with facial arms and anterior cup for the premaxilla was used from age 2 months until 7 to 8 months, when alignment should be completed. Then Johanson carried out his primary bone grafting. A retention appliance was maintained until after closure of the posterior palate at age 1½ years since a certain degree of collapse followed this procedure.
GEORGIADE

At the 1964 Hamburg Cleft Palate Congress, Nicholas Georgiade of Duke University, both dentist and surgeon, noted that since the middle of 1962 he had been using a modification of the expansion screw plate described by Ohlsson and Kling. He explained:

Horizontal expansion can be obtained utilizing parallel expansion devices also incorporated in the acrylic denture, as described, utilizing a split firm acrylic plate with a soft spongy acrylic over the prosthesis as in the solid prosthetic appliance. . . . Following bone grafting of the alveolar cleft area the prosthesis is maintained in position with removal and refitting every few weeks for approximately 2 months.

GRUBER

Colonel Haskell Gruber of the U.S. Air Force is in favor of maxillary orthodontics in cleft palate therapy. In 1966, while at Lackland Air Force Base, Texas, he noted:

At present, over 100 children with cleft lip and cleft palate, ranging in age from 2 weeks to 13 years, are undergoing active orthopedic or orthodontic treatment. Another group of 68 patients has had primary or secondary bone grafting procedures. . . . A record is kept for long-term and longitudinal growth studies. . . . Complacency, as well as the acceptance and use of older techniques only, no matter how true and tried, should not be tolerated without their continuous re-evaluation.

In 1975, at the American Cleft Palate Association meeting in New Orleans, Gruber reported:

With the preponderance of craniofacial growth taking place in the early post-natal months and years . . . it became all the more imperative to achieve normal orofacial growth environment very early in the infant's life. This is accomplished by either repositioning the collapsed maxillary arch segments, or maintaining their normal position and permitting the tension of the repaired perioral musculature to mold them.

The employment of maxillary orthopedics both passive and active accomplishes the following:

1. restoration of a normal maxillary arch contour and maxillomandibular spatial relationships;
2. increase in volume of the oral cavity with better tongue position, improved respiration and speech; 
3. more normal skeletal base for cheiloplasty with concomitant ease of surgical repair with less tissue undermining and subsequent tissue tension; 
4. decrease in incidence of later arch collapse and cross-bite malocclusion; 
5. apparent reduction in posterior cleft width; 
6. better infant feeding habits and early parental involvement with habilitation of their child.

In the early restoration of normal form, function and physiology in the orofacial region, a more nearly normal growth environment is achieved for the tongue, the buccinator mechanism and the orbicularis oris.

M A N C H E S T E R A N D P E A T

Another surgeon who has the benefit of presurgical orthopedics is William M. Manchester of Middlemore Hospital, Auckland, New Zealand. In fact, because of this manipulation of segments prior to surgery, he dares more radical cleft closure than most. As early as 1965, and in the 1971 Melbourne International Congress, he reported having achieved a rather extensive closure of the alveolar and hard palate cleft at the time of his lip closure with the aid of orthodontist J. H. Peat, who presents him with premaxillary and maxillary segments in reasonable alignment. A plate divided in two half shelves overlapped and connected by a wire spring maintains an effective roof to the mouth during lateral expansion, preventing the tongue from pushing on the back of the premaxilla. The projecting premaxilla is restrained by simple elastic traction. At 5 months, alveolar, hard palate and lip clefts are closed, and at 9 months a V-Y palate pushback using Cronin’s nasal slide is accomplished. His 1970 comment on follow-up and final treatment is self-explanatory:

Regular attendance at the follow-up clinic continues until about the age of 16 years. Should it be needed, when the appropriate time comes orthopedic over-expansion of the arch is undertaken and secondary bone grafting is carried out. The missing teeth are supplied by means of the chrome-cobalt skeleton denture which also acts as a retention device. At about the age of 15, a complete rhinoplasty, including elongation of the columella, is done.
WOOLHOUSE

Yet another surgeon enjoying an orthopedic adjunct is Fred M. Woolhouse of Montreal. He wrote me in 1972:

We exploit the McNeil-Burston type of neonatal orthodontia by having our orthodontist insert the appliance usually before the baby’s *first feeding*, i.e., within 12 hours of birth (we have a very compulsive orthodontist and very cooperative paediatricians). Consequently we usually (but not always) repair the lip over a symmetrical arch. The cases from outside the metropolitan area form a good control series since they do not get the benefit of this therapy.

SASAKI

In 1972 Motomasa Sasaki of the Sapporo Medical College, in the *Japanese Journal of Oral Surgery*, presented his use of the McNeil-Burston dental appliance with extending phalanges and attached head and cheek bandages to fix the apparatus in position. He also showed diagrams of what this appliance was designed to do in the various cleft deformities.

O’DONNELL

In 1974 J. O’Donnell, J. Krischer and F. Shiere of Tufts University, Boston, following McNeil’s principle of presurgical orthopedics in unilateral cleft lip and palate, concluded:

1. Unilateral cleft lip and palate patients who have been treated with presurgical orthopedics demonstrate lower incidences of arch collapse and crossbite malocclusion than those treated by surgery alone.
2. A program of presurgical orthopedics results in a reduction of posterior cleft width throughout the course of treatment.
3. The greatest amount of reduction (28.5%) occurs during the period prior to lip repair and the total amount of reduction (45.4%) exceeds that of previous reports of patients who received purely surgical treatment.

In 1977 N. Robertson, W. Shaw and C. Volp of the Orthodontic Department of the Welsh National School of Medicine, Cardiff, used serial cephalometric analysis (with the aid of metallic implants) and an analysis of the models of 10 children with
complete bilateral clefts to study the effects of presurgical orthopedic treatment. They noted:

Successful orthopedic treatment reduced the premaxillary protrusion and the width of the alveolar cleft prior to the surgical repair. . . . The changes were brought about by two complementary effects:

(1) Further forward growth of the already forward premaxilla was restrained by the extraoral strapping which we applied with tension across the prolabium.

(2) Further growth of the remainder of the midface (including the lateral segments) continued, thus "catching up" with the premaxillary element.

If the premaxilla is effectively restrained, the time required for alignment to occur will depend on the rate at which the lateral segments "catch up" as the face grows forward. In our cases this would appear (on the average) to be just under 5 mm. during the first 3 months of life.

. . . Because successful treatment partly depends on normal forward growth of the face, we believe therapy should be commenced within the first days of life when the growth rate is maximal—and it should be completed by 3 months, to comply with the traditional surgical program. . . .

Our other observations include the accentuation of the columella during treatment, but an absence of growth at the cleft margins.

Orthopedic treatment which fails to achieve the desired aims in 12 weeks of active therapy should be discontinued then in favor of such surgical setback as may be necessary to allow a satisfactory lip repair.

PINNING THE PALATE

It is not practical in most areas of the world to hospitalize cleft infants for orthodontic care over long periods as in Burston's unit in Liverpool. Robert Hagerty therefore called upon Willis K. Mylin, orthodontist and anatomist of the Medical College of South Carolina, to help him ensure the maintenance of a maxillary prosthesis with an expansion screw which would require minimal home care. Mylin, who understands construction, having just completed building his large and beautiful house with only the aid of a few subcontractors, turned his attention to this problem and with Hagerty developed the method of pinning the screw plate to the maxilla and sealing off the pins. If fitted and pinned in the early days of life, the expansion plate can be
maintained with relative ease and can have a great influence in positioning the maxillary elements. Mylin is content to leave the apparatus at work for two to six years if indicated.

Robert Hagerty, W. Mylin and D. Hess, in the 1965 *Journal of the South Carolina Medical Association*, described their pin-retained expandable acrylic prosthesis. They defended the need for the appliance in cleft palate when the normal "buttresses" are deficient and presented their case with graphic diagrams of (A) the normal, with equilibrium between the intraoral and extraoral forces, (B) unoperated unilateral complete cleft, with greater intraoral forces displacing the maxillary segment, (C) operated complete unilateral cleft, with greater extraoral force at work, (D) unoperated bilateral complete cleft, with intraoral forces greater, and finally (E) operated complete bilateral cleft, with superior extraoral forces displacing the maxillary segments.

They concluded that their pin-retained expandable prosthesis is most versatile. . . . The advantages of this prosthesis may be listed as follows:

1. Rapid positioning of the maxillary segments.
2. Mechanical closure of the cleft, permitting more facility in taking nourishment and decreasing the amount of food entering the nasal cavity and nasopharynx.
3. Mechanical closure of the cleft, permitting anterior tongue thrust which balances the compressive forces of the lip musculature and also stimulates growth.
4. Mechanical closure of the cleft, permitting anterior tongue tip exploration to stimulate the early development of articulated speech.
5. The pushing compression effect of the tongue on the appliance, stimulating growth at the cleft margins and therefore reducing the size of the cleft.
6. A more normal facial contour resulting from more anatomical positioning of the maxillary segments and vomer.
7. A reduction in responsibility on the part of both patient and parents for the insertion and use of the device.
8. Constant maintenance of the prosthesis in the desired position, eliminating displacement into a non-functional position.
9. Reduction of the nasal quality of the speech.
10. Elimination of parental anxiety associated with external retention and fixation devices, insertions and maintenance of bite plates, feeding difficulties and general appearance of the child.
In 1976 Hagerty informed me that since 1965 he has been closing the velum at 6 months with transverse incisions along the posterior edge of the hard palate, dividing the muscle attachments but preserving the vessels and advancing the soft palate elements medially and posteriorly for union. The screw plate is then inserted, pinned into its position and maintained for six years, at which time the hard palate cleft is closed with the aid of mucoperiosteal flaps when necessary.

In the cleft palate clinic held every other Saturday morning in Charleston’s St. Francis Hospital annex, Hagerty and Mylin, with a speech pathologist, an audiologist, a geneticist and invited orthodontists, meet to see 25 to 30 patients. The children with pinned screw plates are seen every six months for minor maintenance, since the prosthesis can become dislodged during an intensive bout with chewing gum.

In 1977 R. J. Jorgenson, S. D. Shapiro and C. F. Salinas of the Medical College of South Carolina, Charleston, reported on delayed closure in 75 of 180 patients treated with a pin-retained prosthesis prior to surgery:

The results of this study indicate that delayed surgery is related to less interference with palatal growth than early surgery and that the pin-retained prosthesis is a useful adjunct in the delayed surgery.

**PRUZANSKY’S DISSERT**

There has not, however, been universal acceptance of presurgical orthodontics. Orthodontist Samuel Pruzansky of the Illinois Research and Educational Hospitals, Chicago, in 1964 wrote a strong dissent against presurgical orthodontics. He noted that, just as

fads of fickle fashion fade and flow,

maxillary constricting wires are *out*, but with no more justification, in his opinion, jackscrews and spring plates are *in!* He pointed to the role of musculature in the growth of the maxilla and remarked that maxillary collapse was fully, quickly and economically correctable in the deciduous, mixed or permanent dentition.
STELLMACH

Stellmach of Düsseldorf stated in 1964:

We have used early orthodontic treatment of complete clefts since 1954 according to the McNeil technique, but only in a few cases have we used this before lip repair. The procedure is time consuming if not begun within the first weeks of life. . . . Orthodontic treatment, when commenced after lip repair, is aimed at preventing unfavorable approximation of the segments. The plate acts to direct and guide the segments moved by the lip muscle forces into a butt-joint contact. This is obtained within 2–3 months, usually with one correction of the plate. Even outward shifting of the segments can be achieved postoperatively by using several adjustments of the plate or a screw on it.

HUDDART

Huddart, North and Davis of Wolverhampton, England, studied treated and untreated cases in 1966 and found no apparent difference in the two groups of children in later years. Huddart added an extra thought in 1969:

If I have a severe protrusive premaxilla, I honestly think pre-surgical treatment is a waste of time if it is started when the child is more than 14 days old. I refer it to the plastic surgeon as quickly as possible. . . . The child benefits more by an early lip closure.

GLASS

Sussex orthodontist Denis Glass of the Plastic Reconstruction Centre, East Grinstead, made similar findings. In fact, he reported his opinion about presurgical orthopedics in 1970:

1. It does not stimulate maxillary growth;
2. It does not produce “clinical or bony union” of the segments;
3. It delays the time of lip closure until the child is 9 to 12 months old;
4. It draws attention to the child’s deformity at home;
5. It provides added burdens of travel and absence from home to the neglect of the rest of the family;
6. It involves the orthodontist and technicians in work of doubtful value. . . .
As orthodontist, I am responsible for the final alignment of the bony segments of the maxilla and to join these segments by bone before uniting the soft tissues of the face and before restoring the muscle function of cheeks and lips is, in my opinion, of doubtful value.

Glass concluded:

The successful management of bilateral cleft depends on:

1. A careful study of the soft tissue behavior associated with the cleft.
2. Early lip and palatal surgery by a competent plastic surgeon.
3. Rapid dental orthopaedic correction of the three maxillary segments at 4 to 6 years.
4. A course of treatment as short and intense as possible followed by long periods of rest.

Glass had a rather violent youth. While at the University of London, he earned his colors for rugby and athletics, winning the hammer-throwing championship for the Combined Universities of the British Isles. During the war he was in three assault landings in a field ambulance with the infantry fighting from Sicily to Rome. He has indeed earned the good life and now enjoys gardening, hunting, fishing and painting when he is not working on the facially deformed.

SKOOG

In reference to maxillary orthopedics, Skoog stated in 1974:

This tedious process involves using cumbersome headgear and various other apparatus in attempts to bend the premaxilla towards the separated lateral segment. The unnatural pressure placed on the premaxilla is both harmful and unnecessary. The best way of producing alignment is to repair the lip. . . . An exception to this practice is made when the original malformation presents with collapse of the lateral segment. Expansion of the maxillary arch to a suitable position is then recommended.

His orthodontist, Hellquist (1971) used a pair of acrylic plates which act through a fan expansion screw. Lateral rotation of the lateral segments widens the cleft anteriorly.

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Harding and Mazaheri of Lancaster warned in 1972:

Because the spatial relationships of the maxillary segments spontaneously tend to improve, we have become more selective about using expansion or holding prostheses for their management. These prostheses are possibly essential in those in whom there are plans for alveolar operations. . . . Many of the prostheses being used are designed to correct deficiencies in width and this is not a major problem in early infancy—particularly in patients with bilateral cleft lips and palates.

In 1975 M. Mazaheri, at the H. K. Cooper Institute for Oral-Facial Anomalies and Lancaster Cleft Palate Clinic, continued to endorse the standard lip closure at 10 pounds and two-stage palatal closure at 1 to $1\frac{1}{2}$ years, usually without surgery to the area of the alveolar cleft. This was followed by orthodontic treatment during deciduous and permanent dentition if needed, the expansion of the collapsed arch being simple and without irritation. On the basis of a study of 125 complete unilateral cleft lip and palate patients from birth to 9 years under their standard treatment, he and his colleagues reported:

To date, there has not been data of a similar nature published to reveal a more satisfactory oral-facial growth, arch, dental and occlusal developments. Our investigations have shown that it is not necessary to treat the arch in early infancy with a holding or an expansion appliance, since it appears that the arch and the segmental relationship will undergo favorable change with growth and with eruption of the deciduous dentition, provided that growth is not retarded by surgical intervention and scar tissue. . . . The orthodontic cost for correcting a unilateral cross-bite during deciduous dentition is approximately $400 to $500. Primary bone grafting and orthopedic therapy might run into the thousands.

Orthodontist William H. Olin of the University of Iowa, who collects antique music boxes, in the early 1960's became interested in the reports on presurgical orthopedics from Germany, Scandinavia and England. In 1978 he recalled:

I spent 6 weeks travelling in Europe observing the different techniques being used and returned to this country quite excited about experimenting. After several years of using these techniques and comparing the results of patients that had not had presurgical orthopaedics, my conclusions were that
this procedure was not indicated in most cases of cleft lip and palate.

I feel that facial growth is best influenced by simple lip repair at approximately 3 months of age, or a two stage procedure if the cleft is bilateral, one side at 3 months and the other side at 6 months with little or no undermining. I also seem to favor palate surgery after the primary dentition is fully erupted, which would be 2.5 to 3.5 years of age.

Occasionally we do have some severe clefts which are very difficult to close surgically and our surgeon sometimes requests that we help him in reducing the size of the cleft. In these cases we cooperate and attempt to reduce the protrusion of the premaxilla or to close the cleft in the alveolar ridge so the surgeon will be able to complete a satisfactory lip repair. This is the only reason why I feel presurgical orthopaedics is necessary.

HOTZ

In 1976, in the American Journal of Orthodontics, Margaret Hotz and W. Gnoinski of Zurich University Dental Institute took a provocative stand. M. Perko was their plastic surgeon.

The controversy for or against early orthopedic treatment of cleft lip and palate patients still continues. American authors especially [Aduss and Pruzansky] “vigorously” deny its usefulness and are trying to prove that their cases, results of “conservative surgery only,” provide a yardstick against early orthopedics.

Unfortunately, they generally refer to it in connection with primary bone grafting, the effects of which procedure must be considered separately. Some recent publications advocating early orthopedics [Huddart; Maisels; O’Donnell and Robertson] state that it has definite advantages as concerns both growth and development and primary surgery.

Hotz and Gnoinski outlined their comprehensive care developed since 1957, with changes to 1965:

In order to normalize feeding, a plate of compound soft and hard acrylic resin is made as soon as possible, usually within 24 to 48 hours after birth. . . . The plate . . . carefully adjusted . . . is held by suction and adhesion only. . . . The hard acrylic layer provides stabilization of segments in both the transverse and anteroposterior dimensions. The soft parts adapt themselves to the underlying structures, gradually giving way to the increase of the transverse maxillary dimensions. . . . Handling of the plate decisively influences the effects of early orthopedics. . . . Arch alignment is induced by grinding away material in definite areas: in unilateral cases, on the butt ends of both segments. . . . The margins of the palatal shelves are relieved
medially and vertically. . . . In bilateral cases the butt ends of both lateral segments are relieved by grinding in an anterolateral direction. The margins of the palatal shelves are relieved medially and vertically. The premaxilla is supported posteriorly. . . . No active retraction of the premaxilla is carried out. . . . Expansion is often necessary in bilateral cases lacking space either for alignment of a large premaxilla, and/or proper accommodation of the fast-developing mandible. . . . For surgical closure of the lip in unilateral clefts, we consider 5 to 6 months as being the optimal time. . . . The alveolar cleft has considerably narrowed by this time as a consequence of guided and undisturbed maxillary growth. The alar base is carried forward and supported by the lesser segment. . . . Current z-plasties are used for closure, mainly Millard and Tennison techniques. . . . The plate is reinserted immediately after the intervention. It lessens the pressure of the united orbicularis oris muscle on the butt ends of the maxillary segments. . . . For lip closure in bilateral clefts, the Celesnik approach in two stages has proved most adequate. . . . Stage I: Symmetrical closure of the nostrils and nasal floor produces approximation of the three segments which are supported and guided by the orthopedic plate; arch alignment ensues. Stage II: Closure of the lip proper is preferably done by Veau or Manchester cut. . . . Palatal tilting of the premaxilla is prevented by the supporting plate, fitted if necessary with a fan screw in order to allow further adjustments of the segments as well as to exert some counterpressure against scar contracture. . . . A new plate has to be made again at 10 to 12 months of age. Serving now mainly as an obturator, it is worn until a few weeks before soft palate closure. . . . Palatal closure in two stages is used for all complete clefts. . . . Velar closure is performed at about 18 months of age for the sake of speech development; hard palate closure is delayed until the sixth to eighth year. . . . After soft palate closure, no retention appliance is worn. . . . If demanded by the speech pathologist for better speech proficiency (plosives), an inactive plate may be used to cover the remaining gap. . . . Only about 50 per cent of the patients actually need it, usually not before four years of age.
Hotz's logic parallels that of Cronin with regard to the considerable rate of growth during the first six months of life, total body weight being normally doubled, and advocates that one "take advantage of this quite dramatic rate of maxillary growth" within that time and not interfere with it. Hotz and Gnoinski conclude:

The main objectives of our efforts are: (1) to normalize form and function in early infancy; (2) to permit growth to develop to its full potential with regard to functional and esthetic requirements; (3) to render regular orthodontic treatment in the permanent dentition easier and successful in order to avoid large prosthetic reconstruction and/or major secondary surgery.

MECHANICAL PRESSURE

The ultimate in the principle of compression was developed in the 1970's by Georgiade and Latham in North Carolina. In the bilateral cleft with a projecting premaxilla, they attach a coaxial arch alignment appliance with two concentric knobs, one for arch expansion by a pinned maxillary prosthesis and the other for premaxillary retraction. Every turn of the second thumbscrew achieves a 1 mm. posterior displacement of the premaxilla so that with one turn twice daily the premaxilla is positioned within the arch well enough in 9 to 10 days for surgical closure of the alveolar clefts. More detail on this principle is presented in Volume II, Chapter 3.

Maisels' abstracted conclusion in his 1974 article in the British Journal of Orthodontics hits the bull’s-eye of the surgeon’s dilemma:

One wonders whether there is significance in the fact that most of the criticism of presurgical orthodontics has come not from surgeons, but from orthodontists who are either unable or unwilling to provide this service for their surgical colleagues and through them, for their patients.

During the 1977 International Cleft Palate Congress in Toronto, as I listened to experts in various disciplines argue among themselves, my suspicions were crystallized that rubber bands and surgical adhesions are medieval means of accomplishing what skilled presurgical orthopedics can do far better. To ask soft tissue
and the young scars to mold bony elements into alignment is an incorrect order of priorities. It is far better to have the bony base adjusted prior to closure of the lip and retained thereafter, if indicated. This maneuver will reduce the amount of surgery necessary, relieve the degree of tension against fresh scars, prevent the bearing and twisting suffered by the constructed lip against the jutting asymmetrical platform and limit alveolar collapse in response to closure of the lip muscle band across the cleft. Frankly, I particularly resent having my lip scars shoulder any unnecessary stress or strain!

So when Latham made his offer he was welcomed!!

Ralph A. Latham of the University of Western Ontario, London, Canada, who trained with Burston in Liverpool and worked with Georgiade at Duke University, is a research orthodontist with a hobby of migrant beekeeping. He has moved from flower to flower, setting his hives for the bees to feast in the heather of Wales, the blackberries of North Carolina and the clover and goldenrod of Canada. Using Italian queens fed, not on bee bread, but on royal jelly, he hopes to get 100 pounds of honey per hive per year eventually. This is his philosophy on treating the alveolar and hard palate cleft in unilateral cases:

UNILATERAL CLEFT

Present management of the complete unilateral cleft lip and palate condition is prone to a poor nasal appearance, malocclusion of the teeth and maxillary growth deficiency in the form of a depressed facial profile. These features do reflect a persistence of the birth deformity and collapse of the maxillary palatal segments in the first months of postnatal life. The present purpose is to focus attention on the main cause for all of these maladies, namely the cleft in the palato-alveolar portion of the primary palate, which in general practice is never surgically closed. There is good reason to regard the continuing cleft in the dento-alveolar ridge as detrimental to the form and growth of the middle third of the face.

Three factors have been conducive to the decision to leave the anterior palatal cleft. First, there is usually malalignment of the palatal segments at the time of lip surgery. Second, closure later is difficult due to the inaccessibility of the cleft borders behind the intact lip. Third, there is a popular attitude based on consideration of maxillary growth and orthodontic treatment that nonclosure of the anterior palatal cleft may be beneficial.
It is well established that the early associated cleft deformities are amenable to corrective manipulation. It is now possible to arrange the palatal segments favourably for surgical closure by orthopaedic treatment. If anterior palatal closure is performed before proceeding to close the lip, accessibility is not a problem. The indications for giving anterior palatal closure first priority for surgical treatment are now such as to commend this approach.

The main advantages include the following: Closure of well aligned segments using periosteal flaps offers the possibility of bone fill-in of the cleft maxilla. This confers stability to the jaw as a whole. It also provides more normal anatomical conditions for growth of the maxillae. The achievement of good maxillary arch form avoids the problem of malrelated maxillary dental bases which eventually require extensive orthodontic treatment.

**Surgical principles**

The procedure for gingivoperiosteoplasty described here requires a specific optimum alignment of the cleft alveolar segments. These should conform to an arch form with a cleft width of about two millimetres. The surgical procedure has three important principles:

1. Utilization of only palato-gingival mucosa for closure on the oral aspect, and use of nasal and septal mucosa only for nasal floor construction.
2. Turning out the mucosa within the cleft as flaps to effect the closure.
3. Periosteum to be included in flaps as much as possible.

**Requisite of mucosal type**

Palatal and gingival periosteum is associated with prolific osteogenesis on the oral surface of the palate and on the alveolar processes. Use of such periosteum on the palatal aspect of the repair provides an optimum environment for bone growth and the establishment in the cleft site of a normal maxillary growth process. Similarly, periosteum from the vomer and lateral nasal wall has bone resorption function of varying degree, and such periosteum should be kept on the nasal aspect of the cleft site where the continued manifestation of bone resorption would be in keeping with the normal growth pattern.

**Mucosa of cleft borders**

Most of the cleft border mucosa is of an oro-palatal or gingival type which is appropriate for the construction of the flaps on the oral side. This mucosa is of the same kind as adjacent gingival mucosa and tends to have a similar growth pattern. However, for the cleft mucosa to adequately reach across
the cleft site, the palatal segments must be within about 2 mm. of each other.

Use of periosteal flaps
It is important to expose bone on both sides of the cleft and to develop a tube-like lining of periosteum from one segment face to the other. A deep repair is of paramount importance. The most satisfactory part of the repair for its osteogenic potential is posteriorly between the palatal process and the posterior premaxillo-vomer area. Properly performed, the surgery should be followed by the filling of the cleft site by osteogenic cells and fibroblasts which would initially support the periosteal flaps and as early as seven days post-operatively give way to their replacement by commencing bone formation.

In November 1976 Latham wrote me:

I believe I have just the perfect anterior palate surgical design to complement your Rotation-Advancement lip operation. Just thinking of all those beautiful lip operations that conceal behind them an unstable, malaligned, growth retarded, functionally denied and maloccluded dento-alveolar CLEFT that almost no one in North America is much interested in, makes me groan... For ten years, I have known in principle what was needed. This is why this baby is special. With the help of her dentist father, I applied substantial tractional force in a correctional direction with a forward, rather than backward, force vector. The rubber bands and head gear were quite easily handled at home without hindering feeding. Will you do the surgery for this important baby? Gingivoperiosteoplasty should definitely be before teeth start erupting in the cleft area. About 2-3 months appears optimum. Going over 6 months is cutting it fine, although teeth tend to be delayed in eruption in relation to the clefts. This baby is now over 4 months old.

On the first day of December 1976, with Latham assisting, I operated on the baby in Miami to develop clinically a method of treatment employing the principle of sutural adjustment during facial growth (Latham 1974). Here is Latham's report of the case:

The main anatomical problem is that both palatal segments are displaced to the same side, the noncleft side. The premaxillary segment is displaced anterolaterally with an upward tilt of the cleft premaxilla; the cleft segment is retroplaced and collapsed. The nasal septum is bent both anteriorly and posteriorly, which is a basic cause of facial asymmetry and nasal obstruction. The cleft maxilla frequently does not appear to be collapsed, but the collapse shows if the noncleft segment is restored to the midline.
These problems usually preclude surgical closure of the anterior palate and alveolar ridge at the time of lip surgery. Nevertheless, because of his background in basic research in facial growth and development, Dr. Latham thinks that the alveolar ridge should be united at the earliest possible time to optimize normal growth. But the dental arch must be expanded and retained with appliances until the cleft has filled in with new bone that can maintain the dimensions of the palate.

Orofacial Orthopaedic Treatment

The problem was how to pull the noncleft and the cleft segments downward, forward and into a normal arch relationship. Correction of the arch form requires that both segments be drawn by traction in the same direction. This problem was solved by the use of an acrylic intra-oral appliance which was pinned to the palatal processes and, in addition, tied anteriorly by passing a wire over the floor of the noncleft nostril and then around the appliance. The base from which to apply extra-oral traction was provided by a face bow anchored to a custom-fitted head cap. The traction was then placed with a rubber band from the appliance to the face bow. Both the amount and the direction of force were adjustable. Correction of the premaxillary segment towards the midline was obtained with three ounces of traction maintained over a period of three weeks. The traction plate on the cleft side dislodged early in the treatment, resulting in the corrected noncleft side overlapping the cleft side. A Georgiade-Latham expansion appliance was inserted to displace the cleft side laterally and to establish an operating space of about 2 mm. between the cleft alveolar ridge abutments.
While the alar base asymmetry in the case of the unilateral cleft is due primarily to the deformity of the underlying bony structure and its correction does a great deal to establish nasal symmetry, the infant's face may still look asymmetrical due to hypoplastic lip tissues. Final alar symmetry was simulated by pulling the lips together with adhesive tapes. Thus it was expected that some soft tissue growth would both facilitate the surgery and enhance the result.

The orofacial orthopaedic treatment worked well and the cleft palatal segments were well positioned for anterior palate and alveolar ridge construction by gingivoperiosteoplasty.

Orthopaedics Facilitates Early Surgery

Gingivoperiosteoplasty: The Interdigitating Alveolar Flap Method. A new modification of the periosteoplasty procedure was used. The distinctive features are closing the palatal aspect of the cleft using only palatal mucoperiosteum, and using interdigitating gingival flaps to construct continuity of the alveolar ridge. This modification involved no lateral relaxing incisions or denuded palatal areas. The basic incisions were at the cleft borders. Flaps from the lateral nasal wall and from the nasal septum were turned superiorly, and flaps from the palatal mucoperiosteum were turned inferiorly to effect a two-layer closure.

The two main incisions were commenced posteriorly. The first (1-2) on the medial border of the palatal process commenced near the posterior border of the hard palate and the second commenced over the vomer bone (3-4). The position of the vomer incision (3-4) was determined from an estimate of how far the cleft side palatal flap (a) would reach medially; the noncleft side vomeropalatal flap (b) was then cut long enough to meet it. Both of these incisions ended anteriorly at the markings for the lip at the alar base point laterally and at the base of the columella medially.
The curved premaxillary abutment was denuded by raising two triangular flaps, one anteriorly "g" and one posteriorly "e." The gingival ridge on the cleft side was raised as flap "f." This went between the two triangular flaps of the premaxillary abutment to give continuity of the ridge crest. The flaps "c" and "d" came together to close the oral aspect of the anterior palate. Most of the reach here across the cleft came from the palatal flap on the cleft side, which was thoroughly elevated from the palatal bone. The vomeropalatal flap on the noncleft side approximated a little, too, after it had been freed from the bone.

**Lip Surgery**

The anterior aspect of the palate was closed by the lip tissues. A lip adhesion procedure without 1 flap was preferred at this stage for two reasons: first, to avoid compression of a tight lip repair on the newly constructed dental arch; and second, to provide a later opportunity to perform the definitive lip closure after the maxillary arch had been expanded postsurgically, the palate repair had settled down, and new bone supported a stable maxillary base. Postsurgical arch expansion of more than 5 mm. would disrupt a good nasal repair.

**Postsurgical Arch Expansion and Retention**

At three weeks after surgery a new palate impression was taken and another expansion appliance prepared and inserted with pin retention. There then followed rapid expansion of the palate to correct the postsurgical collapse and further expand the alveolar arch. This was a provision to avoid later dental crossbite. In this case, the postsurgical expansion was about seven millimetres in the width of the molar gum pads. The appliance remained in place for the final lip closure by the rotation-advancement procedure, and was removed two weeks later.

Here is an interesting series of models of this case:
October 8, 1976. Traction applied to pull non-cleft side medially and downward. (2 months 17 days)

November 5, 1976. After 28 days of movement of greater segment toward midline. Cleft segment needs expansion. (3 months 15 days)

December 4, 1976. Expansion appliance in 29 days. Arch well aligned. (4 months 15 days)

July 6, 1977. After definitive lip closure. (11 months 17 days)

In October 1977 Latham wrote:

I am still very pleased with the result of our combined efforts. Three similar infants have subsequently been treated.

Then in January 1978:

You will see in the most recent cast I am sending you the arch form looks very acceptable indeed. On the radiograph there appears to be a bony bridge which is obscured by a supernumerary tooth which comes from the cleft maxillary side, so clear definition of the uniting bone is still difficult to assess. The deciduous first molars are just erupting and in another few months they will give a better perspective on the proportions of the arch in general.
Overall, it appears to me that the sequence and timing of treatment has been close to the very best possible and I feel that this represents an historically important milestone in the progress of the treatment of congenital cleft palate. Don’t you think it is essential to get a number of such patients going so that serial records in a long term follow-up study can be obtained to observe antero-posterior growth, the form of the maxillary arch and to see if early prevention of collapse by bone support holds up in the long term?

**BILATERAL CLEFT**

Then Latham and I turned our attention to a patient with a severely protruding premaxilla and "collapsed" maxillary segments. The case was shown to Berkowitz prior to our treatment, and he wrote me:

The evidence is in and one can predict the outcome if you should either surgically attach the premaxilla to the palatal segments and/or close the palate. The outcome will be a malformed maxilla.

It may be a good idea to retract the premaxilla half the distance to the palatal shelves just so you can unite the lip. The case will then react like all your other cases and perhaps turn out equally as well; you need not do more. There is no literature written within the last ten years which supports anything else!

Convinced that the status quo was not good enough and always searching for an improvement, confident that the litera-
ture in the next 10 years will not repeat all the platitudes of the last decade, we proceeded cautiously. Latham’s report follows:

The bilateral cleft lip and palate infant usually shows a protruding premaxillary segment that is a main focus of attention in treatment. However, this problem becomes secondary in those rare instances when the maxillary segments have collapsed to the extent that their gum pads touch in the midline. This extreme malrelationship was the case in the infant Willie M., offering a challenge even for a pinned-screw expansion appliance.

The Miami Cleft Palate Team noted that a lip adhesion procedure by itself could not be expected to retract the premaxillary segment since this was locked out by the collapsed maxillary segments. When Willie was 4 months and 24 days old, Latham inserted a Georgiade-Latham coaxial cleft palate orthopaedic appliance and, by passing a stainless steel pin of 0.036” diameter transversely through the premaxillary basal bone behind the tooth buds, retraction was exerted on the premaxilla simultaneous with expansion of the maxillary segments.

A novel accessory used with the coaxial appliance was the retraction force monitoring system specially developed for this case by Olivier Monbureau at the Dental Research Center of the University of North Carolina at Chapel Hill. This employed a triple light indicator mounted on a black box that also housed small batteries, and its purpose was to show when adjustment of the appliance was required. For the next 4 days treatment progressed well as the appliance was regularly inspected and activated. On the 5th day Dr. Latham was notified that the appliance was not working properly. Subsequently this observation was confirmed and on the 9th day the coaxial
appliance was removed and treatment continued employing a facial strap (Liverpool type) for premaxillary retraction, and a standard Georgiade-Latham expansion appliance for continued expansion of the maxillary segments.

The expansion component used initially in Willie’s case was of a design that allowed maxillary rotation in the coronal plane simultaneously with lateral expansion. So much expansion was required that a spreading of the bridge of the nose was a matter of concern with use of the standard expansion appliance. Although previously used with success on an expansion problem, the rotating-expansion appliance developed a fault when used for the first time with the coaxial retraction component. Correction was quickly performed but in the course of a second attempt to obtain expansion, the maxillary segments collapsed to their original positions. Engaging palatal bones with the retention pins had been a delicate matter from the start, but now faced with renewed force for rapid expansion, insufficient pin insertion in bone combined with the rotation facility in the expansion appliance and permitted unimpeded collapse. At this point, 11 days into treatment, resort was made to the standard expansion appliance normally used. Premaxillary reposition was aided by a facial strap (Liverpool type). Effective expansion was resumed and in the three days immediately preceding the surgery date, or after 14 days of orthopaedic treatment, the 12 mm. of expansion was obtained. Ideally, the premaxillary segment should have been retracted further by a few millimetres still to allow for rebound.

**Orthopaedics Facilitates Early Surgery**

**Bilateral Gingivoperiosteoplasty.** The Interdigitating Alveolar Flap modification was used to reconstruct in two layers the anterior palate and alveolar ridge bilaterally, as shown in these diagrams:
The lip was then closed bilaterally using a lip adhesion procedure. An expansion appliance was made to be inserted post-surgically. The tendency for maxillary relapse was strong since there was no retention for the aligned arch prior to surgery. With this surgical procedure bone tends to form within 60 days, so there is a risk of bone forming across the repair before expansion is achieved. Thus, an expansion appliance to splint the expanded maxillae was inserted several days postoperatively by resident Robert Zaworski and the father instructed to turn the expansion screw ½ turn every other day. When he had expanded to the limit of the appliance (less than one mo.), it was maintained as a retainer for an additional 2 months postoperatively.

On March 2, 1978, a forked flap was marked over the adhesion union, taking portions of the prolabium, adjoining scars and lateral lip elements. A Millard mouth gag was inserted and the cleft in the soft palate closed by splitting the cleft edges and dissecting out and dividing the abnormal anterior levator muscle attachments to the posterior edge of the hard palate. The nasal mucosa was closed with catgut. The levator muscle bundles were retropositioned about 1 cm. and sutured with two 4-0 Vicryl sutures. Then the oral mucosa was closed with 4-0 chromic catgut mattress sutures with one through-and-through suture just anterior to the mended levator sling to prevent anterior drift. The gag was removed and the forked flap banked in whisker position after the lateral lip mucosa and muscles had been joined to each other in the midline behind the prolabium.
Thus, by 1 year of age the forks have been banked for columna lengthening, the lip is closed with muscle union and a mucosal sulcus, the alveolus, hard palate and soft palate are closed and the levator muscle is retropositioned. A retention plate will be used as circumstances require.

Here is a series of cast models made by Latham and Berkowitz to demonstrate the progress of the treatment.

Berkowitz’s comment after following this case was:

The geometric effect on a neonatal palate of a fixed intraoral premaxillary retractive device designed by Latham was reviewed by analyzing serial casts, lateral cephalographs and computerized axial tomography. This study demonstrated that the nasal septum buckles at the vomer-nasal septum junction, and that excessive premaxillary ventroflexion occurs as well. Anterior palatal growth was mainly responsible for the closure of the anterior cleft space. Straightening of the facial profile was mainly due to mandibular growth. Forceful retraction of the premaxilla accounted for a net retrusion of 3 mm. over a ten (10) month period of time. In this case it is too early to determine the effect of early palatal surgery on palatal growth and development.
The buckling of the septum is not serious and is shown by Berkowitz's computerized axial tomographic view of the nasal septum, taken through a plane through the superior orbital fissure and the premaxilla. In my opinion the ventroflexion is minimal compared to that in cases in which the lip has been closed like a bowstring over the protruding premaxilla. Although the total premaxillary retrusion might have been only 3 mm., it was about 9 mm. at the time of gingivoperiosteoplasty, rendering the operation feasible. It is heartening that Berkowitz does admit some excitement at studying this approach only for these severely protruding premaxillas and has encouraged Mazaheri and Olin to join him in experimenting with it and recording results. He noted:

There are certain cases that will ultimately need surgical premaxillary repositioning. If these cases were identifiable at the newborn stage, then forceful repositioning might be of use. Unfortunately, there are still no all-conclusive predictive parameters. Friede and Pruzansky (1973) have reported that in those cases in which the distance between the premaxilla and the anterior portion of the lateral palatal segments is greater than...
25 mm., the growth prognosis is poor. Possibly these cases might be good subjects for this approach, always remember that selectivity of cases is of prime importance. Forceful retrusion should not be performed for all complete bilateral cleft lip and palate patients. The effects of this procedure on midfacial and septal growth have still not been documented. Other investigators have to monitor these results since the originators of this procedure have failed to do so. In this case the early closure of the palatal cleft will mask the effects of forceful premaxillary retropositioning; therefore, better controls need to be established to more accurately evaluate its utility.

In 1979 Berkowitz added:

I do not see any reason for the lateral expansion of the maxillary palatal segments at the newborn period. This case does demonstrate that after Latham expanded the palatal arch it returned to its original dimension when the appliance was removed. Any further palatal arch width change that occurred was due to growth and not to palatal manipulation. This increase in palatal width is predictive in almost all instances, provided there has not been any inhibiting scar tissue.

Berkowitz has since voluntarily used the Georgiade-Latham apparatus on two bilateral clefts with severely protruding premaxillae. I see a hope for progress here!!
17. Early Maxillary Bone Grafting

The first bone graft to a cleft palate was carried out in 1901 by von Eiselsberg when he grafted an entire little finger—bones and all—into the cleft. The first attempts at bone grafting in growing cleft patients were made by Lexer in 1908, and the first successful bone graft to an alveolar cleft is attributed to Drachter in 1914. Veau’s effort in 1931 to fill a cleft palate defect with tibial chips failed. Then there was an interval of indifference to this approach.

In 1952 a subtle preface to the osteoplastic era was provided by Axhausen, who wrote:

All attempts to induce bony healing through excision of mucosa in the area of narrow clefts and freshening of underlying bone surface have proved futile. . . . If there were a means of inducing subsequent bony healing between the premaxilla and the lateral fragments, this approach would be preferred; it would then be possible to preserve well-formed incisors. To find such means appears to me to be the final problem in the repair of complete clefts at present.

Suddenly almost everyone began bone grafting or apologizing for not doing so. In fact, the world literature on alveolar bone grafting read like a roster of the elite in a German Panzer Division as compared with the sparse but strong guerrilla bands from Sweden, U.S.A., Yugoslavia and Britain.

SCHMID

In the modern era, Eduard Schmid of Stuttgart was the first to implant bone in infants with clefts. On the occasion of the
Austrian Meeting of Dentists in 1951 to 1952 at Bad Aussee, Schmid reported several cases of cleft lip and palate in which he implanted small iliac bone grafts between the maxillary stumps after surgical closure of the cleft in order to prevent contracture in the cleft area. With multiple publications on this subject beginning in 1954, he struck the sparks that ignited an intense interest in bone grafts in the cleft maxilla throughout the world.

His follow-up report 23 years later is of great importance. Eduard Schmid, Werner Widmaier, Heinz Reichert and Klaus Stein in 1974 stated their present stand. Since 1962, 87 children with clefts of the lip, alveolus and palate (80 percent unilateral and 20 percent bilateral) have been treated by a modification of primary osteoplasty not only of the alveolus but also of the hard palate at the time of closure of the lip, usually at 8 months of age. Using compact and spongy layers of hip bone for grafting, Schmid and his colleagues noted:

We lay great emphasis to atraumatic handling of the involved tissue, mobilizing two flaps at the vomer and the lateral edge of the gap, which are rotated horizontally, thus obtaining two layers of mucous membrane to line the oral and nasal cavity. The space is filled with bone. Since only the actual margins of the cleft are involved, the blood supply of the alveolus and hard palate remain unimportant. At age 7 years the remaining cleft of the velum is closed, either by the method of Veau (1931) or, if feasible, again leaving the palatine arteries intact by the method of Widmaier (1961).

They concluded:

We now utilise primary osteoplasty in wide clefts, and achieve satisfactory results. However, we do not use this method in cases of primary compression, where the maxillary arch is first aligned by the orthodontist, before we stabilise it later by bone implant as Nordin and Johanson (1955) recommended.

**JOHANSON**

At about the same time Bengt Johanson of Sweden became interested in bone grafting the alveolar cleft. In 1955 Nordin and Johanson used a block of cancellous bone in the alveolar defect and chips of cancellous bone along the hard palate. Their bone
was obtained from the tibia in primary cases and from the iliac crest in secondary cases. In 1961 Johanson and Åke Ohlsson described their three-stage treatment of clefts:

The initial operation is performed at the age of three to four weeks without special prior treatment. The nasal floor of the hard palate, in one layer, is closed with a vomerine mucosal flap and anterior to the alveolar process by direct adaptation of the labial soft tissues in two layers. The vomerine flap, which on the oral side is first covered with granulation tissue, has after some few weeks a stable covering of secondary epithelium. At this junction, the orthopaedic correction of the jaw is started and continued up to the age of six months. Special expansion plates are used, fixed to a head cap by means of extra-oral shafts. At the second operation, the components of the upper jaw should be ideally positioned in relation to each other and in correct occlusion. Careful repair of the lip is now combined with transplantation of autografts, chips and marrow, in the cleft in the hard palate and alveolar process. The donor site is tibia. . . . A continuous orthodontic control is subsequently kept until the permanent bite is fully developed. At the third operation which is usually performed at one year, the posterior palate is closed. . . . The treatment has been completed in 27 primary and 31 secondary cases. The graft united and a stable homogenized upper jaw was secured in every instance.

**SCHRUDDE**

In 1957 J. Schrudde, while with Rehrmann in Düsseldorf, first published his plan of primary bone grafting to cleft cases using autogenous rib to bridge the defect anterior to the alveolar processes. In 1959 he readvocated this principle with R. Stellmach.
In 1965 Schrudde, now at the University Clinic, Cologne, Germany, reaffirmed his advocacy of primary bone grafting in the *British Journal of Plastic Surgery*, stating:

The procedure, however, had a favourable effect on the development of the upper jaw and the cutting of teeth. The graft also improved considerably the position of the base of the nose immediately above the lip.

He described his more recent approach:

I have of late been closing the palate after primary osteoplasty during the 14th, 15th or 16th month but I have also been performing plastic surgery on the palate at the same time by grafting a rib chip in the hard palate region from one edge of the cleft to the other. This rib chip across the cleft is there to stand up to scar contraction and it therefore guarantees that the upper jaw will develop in a normal way. . . . I apply the bridge flap method as does Axhausen, but I retain both vascular and nerve tissues at the major palatine foramen [which] serves as a more nourishing bed. . . . The important point is that this type of osteoplasty permits a very early cleft palate operation to be performed.

In 1971, after 12 years, Schrudde was still enthusiastic:

Encouraged by our experience of primary bone grafting, we have now altered that operative procedure and advanced the time of operation. The palate is closed by means of primary osteoplasty when the child is approximately 1½ years old and beginning to talk. . . . Under these conditions, the maxilla is able to put up more resistance to postoperative scar tension and is more stable owing to the fact that the alveolar graft has become consolidated, supplemented by the primary bone graft of the hard palate.

In 1972 Schrudde reported follow-up of his primary bone grafts, revealing good and bad results. This stimulated him to
continue the evaluation, which he reported at the Spanish Plastic Surgeons meeting in Las Palmas, 1976. Thirty-six patients from his group of 50 were reexamined while 14 did not return, probably because of satisfactory results. In order to demonstrate the influence of primary osteoplasty on the formation of the maxillary arch, occlusion in three planes (sagittal, transverse and vertical) was presented. The sagittal plane gives information on the degree of pseudoprogenia; the transverse plane reveals the palatine dislocation of the maxillary arch on the cleft side; the vertical plane measures the open bite. From 1972 to 1976 there was improvement in the positioning of the jaws in all planes.

The improvement can be attributed to intensive orthopedic treatment, and, as followed by x-ray studies, the transplants have become fully adapted functionally and firmly integrated in the maxillary arch.

To facilitate the evaluation of the x-ray films, a grade grouping of the transplants was outlined by Schrudde in accordance with their structure and size:

Group 0: Functionally fully inserted chip, clearly structured. The axes of the teeth near the cleft are almost parallel.
Group I: Functional adaption unsatisfactorily advanced; clear convergence of the teeth near the cleft.
Group II: Pseudoarthrosis or considerable loss of transplant substance with pronounced convergence of the teeth near the cleft.
Group III: Loss of the transplant or incomplete bone bridging of the cleft.

In 1972 the transplants were graded by groups and four years later regrouped. The improvement was impressive, as shown in the table.

A bite imprint of the upper jaw and the Panorex shot increased the reliable assessment of the transplants. Schrudde noted:

X-ray evaluation of the transplants is in many cases made more difficult by dentition and by superimposed parts of the bony facial structure, as seen in this case published in 1973 and re-evaluated in 1976.

Schrudde explained that the positive development on the part of the transplants was the reason for the improvement of the jaw positioning. He also clarified factors in the apparent improvement:

<table>
<thead>
<tr>
<th>Plane</th>
<th>1972</th>
<th>1976</th>
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</thead>
<tbody>
<tr>
<td>Sagittal Plane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>normal</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>1 on 1 palatoversion</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>22 = 61%</td>
<td>29 = 81%</td>
</tr>
<tr>
<td>Transverse Plane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>normal</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>3 on 3 palatoversion</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>17 = 7%</td>
<td>18 = 50%</td>
</tr>
<tr>
<td>Vertical Plane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>normal</td>
<td>25</td>
<td>26</td>
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<tr>
<td>1 on 1 unerupted teeth</td>
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<td>3</td>
</tr>
<tr>
<td></td>
<td>28 = 78%</td>
<td>51 = 86%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP</th>
<th>1972</th>
<th>1976</th>
</tr>
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<tbody>
<tr>
<td>GROUP 0</td>
<td>20.4%</td>
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<tr>
<td>GROUP I</td>
<td>39.7</td>
<td>28.5</td>
</tr>
<tr>
<td>GROUP II</td>
<td>22.4</td>
<td>8.2</td>
</tr>
<tr>
<td>GROUP III</td>
<td>18.3</td>
<td>8.2</td>
</tr>
</tbody>
</table>

303
All those cases in which x-ray pictures were taken during the cutting of teeth reveal a distinct reaction on the part of the transplant to functional stimuli. In many cases we found that the tooth piercing its way almost rarified the osteoplasty, till then well stabilized, down to narrow marginal areas. After the tooth had come through, we found in all cases we observed that there was a complete regeneration on the part of the transplant as seen in this 12 year old female.

Further evidence of adaptation of the transplant is seen in the processes of accumulation and breakdown as well as increase in thickness in certain areas of the transplant. The extreme degree to which an implanted piece of rib-bone can take its place in a stress system is demonstrated in these two x-rays.

Schrudde noted:

The 1963 figure shows a freshly implanted rib-bone, which has been positioned very far forward in the maxillary arch, a place that we do our very best to avoid these days. The 1964 figure shows the same transplant one year later. Processes of accumulation and breakdown have moved the transplant into a position through which the stress plane of the maxillary arch clearly runs. This process of adaptation promises that during further development the original bone transplant will be able to react to local stress in the required manner.
Schrudde summarized:

Assessment of primary osteoplasty in respect to its efficiency is completely satisfactory.

1. With increasing age on the part of the patient, there is significant improvement in occlusion.
2. Individual observations during dentition clearly show that the transplanted bone is not a passive bridging element.
3. The analysis of the process of accumulation and breakdown and especially of the spread of thickness shows that the transplanted bone is functionally adaptable. . .

A cleft which has not been closed using bone will never be in a condition in which the jaw can react in a physiological manner to the demands made. Only primary osteoplasties promise to create conditions under which stress involved meets a system which, by virtue of its bony completeness, can react in a physiological manner to this stress.

In conclusion, this occurs only if the surgery is correct. First the bed of the transplant must show no gaps, either in the oral or in the nasal direction. Suture dehiscence and infection in recent years has become a rare
occurrence. A complete rib segment is used as the transplant and this is cut in the shape of a V at both ends to ensure better positioning. It is desirable for the rib segment to be inserted under light tension. We have not experienced complications in taking out the rib and have operated on far in excess of a thousand children.

**BÄCKDAHL**

In 1961 in *Acta Chirurgica Scandinavica*, musical M. Bäckdahl and dedicated K.-E. Nordin of Stockholm advocated bone grafting both the alveolar cleft and the remaining maxillary defect. This was facilitated by partial resection of the inferior turbinate in preparation for a modified Campbell two-layer cleft closure. They turned the septal flap down to cover the oral side and the lateral flap up to close the nasal side and packed “tib chips” of bone between the two. An x-ray follow-up (a) before bone graft, (b) three weeks after bone graft and (c) 12 months after shows adaptation of the bone structure.

**NYLÉN**

Bengt Olof Sixtus Nylén of Karolinska Hospital, Stockholm, an international traveler, was trained in plastic surgery by G. Webster and W. Pierce in California and T. Skoog in Sweden. In 1973 Nylén wrote me:

Bengt Johanson left Stockholm for Göteborg around 1957 but interest in primary bone grafting was maintained by Karl-Erik Nordin and Magnus
Bäckdahl, who in 1959 designed a four-flap method. Mucoperiosteal flaps with their bases along the cleft are brought together in pairs, to form a cavity in which the bone is inserted. In some cases, the anterior part of the inferior turbinate may be partially transected or used if needed. The rib grafts are placed with a large piece on the inside of the oral lining, another on the undersurface of the nasal lining and many small pieces packed between the two main struts. The anterior defect is lined by a mucosal flap from the sulcus.

In 1966 Nylén reported 254 cases, 66 with early bone grafting and 188 with late bone grafting, by this same method. In 1973 he wrote:

We have a special jaw orthopedic unit of 15 beds where the infants are brought at 2-3 weeks of age. The preoperative jaw orthopedics is started immediately by Nordin who is the full-time orthodontist. . . . After good alignment of the upper jaw, the early bone grafting operation is performed. . . . We have followed these cases and believe that so far the results are quite promising. We have not seen any deformities as have been reported in different bone grafted series with other methods. The crossbites found in these cases are about the expected frequency of other series. Cephalometric examinations show development similar to the normal facial skeleton. . . . With this treatment the patient is rehabilitated at a young age with a minimum of operations and with promising results.

At the 1973 Cleft Palate Congress in Copenhagen one of the original authors, Karl-Erik Nordin, with Arnander, Barr, Leanderson, Körlof and Nylén of Stockholm, reaffirmed the original 1963 Washington, D.C., Congress approval of early maxillary bone grafting. They gave a 7- to 12-year follow-up on the cases operated on between 1960 and 1966, 70 percent of which had been grafted before 6 months of age and another 22 percent before 12 months. The studies included casts, x-ray films and photos, hearing and speech tests, evaluation of appearance and function of the nose and lip. According to their evaluation of the 73 early primary bone grafts in the bilateral clefts, there were 20 with no crossbite and 36 with only canine crossbite. Appearance, speech, facial skeleton and ear function all compared favorably with those in the non-bone-grafted cases. Nordin went one step farther to describe his approach to transplantation of teeth to the bone grafted alveolar cleft when migration had not occurred. He presented a number of cases.
The endodontically treated and filled root is placed in the split and excavated alveolar crest and surrounded by small chips from the excavation. The root is covered with the mucoperiosteal flap elevated before the procedure. The development of the periodontal structure is followed by X-ray until it is time for applying a crown.

Finally, in 1974, Nylén, Körlof, Arnander, Leanderson, Barr and Nordin reported primary bone grafting in complete clefts and concluded:

From the point of view of appearance, the results were excellent or good in 80% of patients with unilateral complete clefts. The corresponding figure for bilateral cleft group was only 50% and 50% of these patients needed secondary operations. . . . In speech assessment, reduction in open nasality and improved articulation (particularly consonant production) were noted in the bone-grafted group. . . . The results presented . . . appear to us promising and indicative of a need to pursue further this form of treatment.

WIDMAIER

Werner Widmaier, a war-wounded patient of Schmid’s, modified the method in 1959. In 1964, at Schuchardt’s Second Hamburg Symposium, he and Schmid gave their reasons for bone grafting:

Check-ups of the complete cleft-palate cases showed . . . in a good percentage of the unilateral clefts the dental arch developed normally.

However, mostly in bilateral clefts, contracture of the dental arch could not be avoided. These experiences led us to the primary simultaneous osteoplasty into the cleft of the bony structures.

They presented their method of dissecting the mucoperiosteal flap from the lateral cleft edge. The lateral flap was used for nasal closure and the vomer flap for oral cover, and bone from the ilium or rib was inserted between the two. This maneuver achieved a two-layer closure with bone between both in the alveolar area and all the way back to the posterior edge of the hard palate. They then used Widmaier’s method for the soft palate.
REICHERT

Heinz Reichert, a former student of Schmid, gave an interesting comprehensive review in 1969, putting events in perspective:

The development and method of bone grafting used in 450 unilateral and bilateral clefts at the Stuttgart Clinic will be described. From 1951 to 1955, bone was grafted 3-4 weeks after the primary lip repair . . . . By 1956 both procedures could be done in one operation, as published by Stellmach and Schrudde at that time. The children are 7-8 months old at the end of surgery.

The x-ray controls from 1951-6 and the findings with the 2-stage cases demonstrated that the bone graft, when it "took" on both stumps had suffered a deformation after 2-3 years . . . so that only a small step was left. At the same time the alar bases and nasal floor sunk slightly and at the alveolar process and hard palate the mucoperiosteum contracted upwards. In severe clefts, in spite of bone grafting, we discovered a slight collapse in the premolar and molar region which gave to the alveolar arch the hint of a lyre shape.

The practical result to come out of these observations was to enlarge the bone grafts in both vertical and horizontal dimensions. In the vertical dimension we now fill the cleft with a "bone span" extending from the nasal floor, alar base and pyriform opening down to the alveolar edge. Horizontally, the bone graft extends from the anterior edge of the maxillary arch to the posterior edge of the hard palate. In areas where resorption is expected since there is little or no functional burden in the first years after surgery, particularly in the nasal floor and alveolar ridge, we have grafted cartilage from the "pelvic edge" (Beckenkamm)—this is usually not resorbed and is not replaced by bone until 14-16 years.
The determining factor for bone graft success is soft tissue coverage of the bone graft. Based on Wassmund's (1939) two-layered closure of the nasal floor, combined with Campbell's and Pichler's techniques for closure of the hard palate, Widmaier (1956) developed his own method which allows bone grafting of the complete cleft area. . . .

The primary operation works positively not only on the width of the maxilla but also on the nasal symmetry, contour of the upper lip, alveolar edge and palatal vault. We no longer see depressions of the alar base on the cleft side because the pyriform "ring" is closed by a cartilage-bone graft which forms a lasting foundation.

**Bone Grafting Clefts of the Velum**

In 1967 Reichert began to apply osteoplasty to wide clefts of the velum alone, since here too he had observed partial contraction of the molar region in the maxillary arch following cleft closure. In 1970, in the *British Journal of Plastic Surgery*, he explained this occurrence and gave his solution:

This is quite understandable when the difference between healthy and cleft palates is borne in mind; the roof of the normal is arched like a bridge from one tuberosity to the other, while in the cleft palate, the frontal part of the maxillary arch is like the middle of a bow, the free ends of which can be bent towards one another by the tension of a cord, in this case represented by the scar. . . .

In wide palatal clefts therefore we now implant a triangular piece of iliac bone, completing the roof of the hard palate, giving the closed soft tissue layers support, reducing scar formation, preventing maxillary compression and shaping the palate to normal roundness.
This indirectly improves speech results since the movable soft palate does not become shortened by contracting scars and has a solid base for the new attachment of the muscle fibres mobilised from the edges of the clefts. If in some extremely short palates a pushback procedure has to be performed later, the result is stabilized far better by the incorporated bone. Furthermore, as cleft patients grow older, the function and retention of a dental prosthesis will certainly be better on a solid hard palate.

Reichert concluded:

It is considered that at least 10 years after operation is necessary before final assessment. This period has already elapsed in some 150 cases of complete clefts (lip, alveolus, and palate) treated with primary bone grafting and we have observed a significant improvement; most cases show no compression at all.

SCHUCHARDT

Professor Karl Schuchardt of Hamburg, head of a 450-bed maxillofacial surgery unit in a Berlin military hospital during the entire Second World War, has been a leading force in Germany ever since then. We had the pleasure of visiting his charming home (as shown) during the Second Hamburg Cleft Palate Symposium. Schuchardt has employed primary osteoplasty and bone grafting to the alveolar cleft at the time of lip closure at the Nordwestdeutsche Kieferklinik since 1958. By the time of his report with Pfeifer and Kriens at the Rome Congress in 1967 he had 419 cases.

The combined procedure was performed at 6 months of age. He created the alveolar pocket for his bone grafts from local nasal mucosa for lining, like Veau-Axhausen, and from buccal mucosa with his improved modification of the Burian-Trauner flap to get more tissue for oral cover. For wide clefts he admitted using Stellmacht's vomerine mucosal flap.

With a typical North German show of strength, Schuchardt advocated the use of two full-thickness rib grafts. These were dovetailed at both ends to straddle the alveolar gap at the edge of the pyriform aperture so as to fill the bony defect and support the alar base.
In some cases he extended the bone grafting into the hard palate area, laying cross-strips of split rib.

According to Schuchardt:

A most important characteristic of the solid rib graft is that it is able to withstand the pressure of the united muscles, predominantly the orbicularis oris. Thus the rib graft not only prevents collapse of the lateral maxillary segment but also transmits the pressure from the premaxilla to the lateral segment and forces it outward.

This action improves the development of the alveolar arch. It should be stressed that the implanted rib acts by orthopaedic means, thus eliminating any preoperative orthodontic treatment and reducing the later postoperative treatment to minor orthodontic measures.

Another advantage of solid rib transplants, which keep the alveolar segments at their proper distance apart, is that crowding of teeth close to the cleft will be improved as adjacent teeth migrate into the incorporated grafts. Thus primary osteoplasty is an important physiological means of improving dental alignment. Since the transplanted bone has no inherent growth potential, teeth which have moved into the incorporated grafts favour regional bone growth.

In his enthusiasm for his own regimen, Schuchardt attacked Herfert’s opinion:

My experiences are incompatible with Herfert’s opinion [based on findings in the dog] that the detachment of the palatal muco-periosteum is the cause for the underdevelopment of the hard palate later on.

He expressed his suspicion that the postoperative deformity was caused not by the detachment of palatal flaps but by contracture in the area of the cleft closed with nasal mucosa only. He reemphasized that his satisfying functional and aesthetic results had been achieved by surgery alone.
One of the outstanding German leaders in cleft palate surgery is Rudolf Stellmach of the University of Berlin. His acute sagacity and unusual generosity have made it possible to include several rare portraits in these volumes. One of Stellmach's important contributions has been his modification of the vomerine flap used for oral closure of the alveolar cleft. He first presented this method in 1959, and it has been adopted by many surgeons throughout the world. As he stated in 1964:

In our experience anterior lip mucosal flaps are limited to smaller clefts since branching off a wide lip flap may cause too much loss of inner lining of the lip and a narrow vermillion border.

Therefore, in the large type cleft we prefer to cover the bone graft from behind. The vomer flap is raised in its full length, but the posterior part is cut in at the cranial base from behind to the front, forming a tongue-like flap. It is turned forward to serve as the back and oral layer of the bone bed.

In 1976 Stellmach wrote:

We still do bone grafts to the alveolar gap and we use the tilted vomer flap [Stellmach] for covering the autogenous rib implant exclusively. Nevertheless the indication for primary bone grafting has been minimized to extreme total clefts. That means clefts with a severe hypoplasia of the alveolar arch bone in the cleft area. Determination can be made on either intraoral x-rays or on the basis of simple clinical judgement or orthodontic measurement of the alveolar arch length in comparison to the opposite side. In these rare cases, the central incisor tooth buds will be absent, along with or without the lateral incisors. Early bone grafting helps to prevent a severe collapse of the arch.
In 1977 he added:

Formerly when we closed the hard palate at the time of lip repair, we often got overriding of the arches and secondary arch malformation. If narrowing is produced strictly between the alveolus of both cleft sides, the alveolar arch will abut end-to-end within a few months' time. It is my feeling the surgeon should assist arch alignment as far as possible by careful selection of his procedures.

BRAUER AND CRONIN

In 1962 Brauer, Cronin and Reaves reported their first 10 cases of early maxillary orthopedics and alveolar bone grafting. Then at the American Cleft Palate Convention in Washington, D.C., in 1963, Brauer and Cronin were the delegates from Texas promoting the combination of maxillary orthopedics and anterior palate bone grafting. They reported two and one-half years of experience with the McNeil principle: using the motor force of the baby's gumming and sucking from within, working against an acrylic plate, to guide the maxillary elements into alignment.

At 1 to 2 weeks of age the infant was brought to the office, and Brauer or Cronin took an impression of the arch in warm Kalginate. That same evening a dental student poured the impression into stone and later prepared a plate with an expansion screw. The plate was inserted and the mother instructed to turn the screw once a day or once a week, depending on the need for expansion. For a protruding premaxilla in a unilateral cleft, a bypass plate was employed, and an elastic band attached to a cloth headcap was used to bend the premaxilla around. This action took about two months and was followed by lip closure.

In bilateral clefts, the lateral maxillary segments were expanded by the screw plate while elastic traction was applied to the protruding premaxilla.

Once the relationship of the upper arch to the mandible was as close to correct as possible, the bone graft was inserted. The insertion had been made as early as 4 months of age, with an average of 8 to 12 months, and had been done before, during and after anterior palate repair.

As Scott of Ireland demonstrated that forward growth of the maxilla occurs primarily along the septal-maxillary junction,
Brauer and Cronin reasoned that fixation of the retarded cleft segment to the normal, growing maxillary segment should provide orderly advance of both elements. They gave their threefold purpose in bone grafting:

1. To fix the cleft maxillary segment to the normal side.
2. To provide support for the teeth in the region of the bony cleft.
3. To build out the flat contour often seen on the cleft side of the maxilla.

They turned a vomer mucosal flap over and sutured it to a mucoperiosteal flap from the cleft side for the nasal closure. Rib grafts were used as onlay strips, wedges into the alveolar gap, and chips. The oral cover was supplied by advancement of the labial mucosa over the bone grafts and suturing to the vomer flap.

HORTON AND OTHERS

At the same Washington Cleft Palate Convention in 1963 a Virginia contingent of Horton, Crawford, Adamson, Buxton, Cooper and Kanter reported similar interest in prosthetic prevention of maxillary collapse and fixation with bone grafting. They claimed 63 bone grafts since 1957 and noted that they appear to help prevent maxillary collapse . . . aid in the development of teeth adjacent to the graft and help fill out the alveolar ridge contour.

Georgiade, Pickrell and Quinn reviewed 2,200 of their cleft lip and palate patients at the Duke University School of Medicine and concluded:
It became clear to us that many of our results, particularly in the bilateral cleft and complete alveolar cleft group, were short of our desired goals from both functional as well as esthetic standpoints.

Over a two-year period they visited various European maxillofacial centers in Prague, Göteborg, Uppsala, Düsseldorf and Hamburg and were impressed that, in spite of the enthusiasm of the individual surgeon for a particular procedure, no one surgical procedure could be used for closure of all various sizes of alveolar clefts . . . but . . . the replacement of the missing segment of the alveolar arch with a bone graft appears to have considerable merit . . . stabilization of the arch . . . prevention of collapse.

Although they expressed preference for cancellous bone taken from the ilium inferior to the crest, they suggested three ways of using a rib graft: (1) H-shaped strut wedged between the alveolar ends, (2) linear separation of the rib ends and insertion into the cleft and packing with chips, or (3) rib chips used to fill the mucoperiosteal pocket.

It was their feeling in 1964, with 42 cases in various stages of orthodontic treatment and bone grafting, that these procedures singly or in combination will become a part of the overall management of patients both as primary and secondary procedures.

ČUPAR

Professor Ivo Čupar of Zagreb, Yugoslavia, in 1964 noted that secondary maxillary deformities occur only in total clefts, while in subtotal ones with an intact alveolar arch there is no clinical evidence of such changes. Thus he reasoned:

Primary osteoplasty converts total clefts into subtotal ones and this considerably diminishes the likelihood of developing deformities.

Yet the transplanted bone must be protected from the stress and strain until fully consolidated. Having this precaution in mind, Čupar explains his approach:

In small children 1 or 2 years old following osteoplasty and complete cheiloplasty, I usually introduce an orthodontic plate to maintain the
existing shape of the alveolar arch: to resist for a few months an undesirably strong pressure of the lip.

PREVOMERINE GRAFT

For special bilateral bone grafting of the clefts, several surgeons turned to thrifty use of the excess bone. In 1960 Oberniedermayr of Munich advocated surgical repositioning of the premaxilla between the lateral segments, using the resected prevomerine bone for grafting. He created a small bone bed with little local flaps and stabilized the premaxilla by Kirschner wire transfixion. In one of his double cleft lip and palate operations the transplanted bone was lost by infection after two weeks, but bone consolidation occurred similar to that described by T. Skoog.

PFEIFER

Pfeifer of Hamburg, assistant to Professor Schuchardt in 1962 and later in 1964 reported a method of triple osteosynthesis he developed for exceptional cases of bilateral clefts with extreme protrusion of the premaxilla. Mucosa was turned to form a bed for the transplants. A cylindrical piece of prevomerine bone was taken, split into two pieces and inserted into both alveolar clefts to fix the alignment of the retroposed mobile premaxilla. Pfeifer claimed a stable union with symmetry.

SCHRÖDER

Friedrich Schröder of Würzburg is another who favors early bone grafting. In a 1973 book edited by Schuchardt, Steinhardt and Schwenzer he reported early rib grafts in the form of full-thickness struts across the gaps in both unilateral and bilateral clefts at the primary operation. To the question about subsequent maxillary deformity, he stated:

With orthodontic treatment growth disturbance can be avoided.
Clarence Monroe of the Chicago Children’s Memorial Hospital reported in 1969 a four-year follow-up. He had closed the lip under local anesthesia between 2 weeks and 3 months of age, or at a weight between 7 and 10 pounds. A day or two before, Bailey Jacobson and Sheldon Rosenstein had fabricated a prosthesis to cover the hard palate from the canine teeth back to the tuberosity with enough extension of soft acrylic into the cleft on the superior aspect to achieve retention of the plate. After lip closure the plate was inserted. Muscle pull rotated the premaxilla, but the plate prevented narrowing of the cleft until the premaxilla was back in good arch form by 1 to 2 months, or even 4 to 10 months. When the premaxillary ridge was touching the lateral alveolar ridge, the position was stabilized with a rib bone graft. A prosthesis protected the bone graft two months for stabilization of the graft. At 1 to 1 ½ years, a von Langenbeck closure of the palate was achieved.

In 40 cases treated over four years, no instances of severe contracture of the upper dental arch have been seen. In two cases, when the alveolar ridge lined up excellently, palate closure was done at the same time as the bone graft. This procedure promptly pulled the alveolar ridge off alignment into crossbite. Monroe and Rosenstein feel that

Position of the arch should be stabilized with well-healed bone graft before palate is repaired.

Mellifluous Sheldon Rosenstein, holding dual professorships in orthodontics at Northwestern University in Chicago and St. Louis University in Missouri, is also the orthodontist working with Clarence Monroe. In 1967 he described management of the maxillary segments in complete unilateral cleft patients. He reconfirmed his stand at the Duke University Cleft Palate Symposium in 1973, stating:

We claim no panaceas, and we do not think it is the only approach. It is an approach and carries with it a definitive sequence of procedures. In essence,
it consists of (1) the placement of an intraoral prosthesis prior to lip closure, (2) molding of the arch segments, (3) stabilization of the segments by means of autogenous bone graft, and (4) retention of the prosthesis until palate closure. We are generally finished with the early infant procedures when the children are 15 to 18 months of age.

Two major avenues of legitimate investigation and concern should now be mentioned. First . . . does early maxillary orthopedics and osteoplasty do any harm, and second, do these procedures do any good?

Rosenstein admitted that his oldest patient in this series was only 7½ years and therefore he did not know the answer to either question. He did note that at 5 years of age some good and no harm was evident. He concluded:

Despite disenchantment in some quarters, we are not yet prepared to abandon these procedures. On the contrary, we are still very much excited about them.

Since then Rosenstein has co-edited the comprehensive book *Cleft Lip and Palate*. In 1975 in the *Angle Orthodontist* he concluded:

Thus far, we are able to state that in our sample, using our treatment procedures in the sequence advocated, we have seen no growth attenuation in the posterior/anterior dimension. The maxilla, at least to the ages observed, does not appear to have been attenuated by our procedures.

Further, it would seem that after a limited first phase of orthodontic treatment to align dental units, the degree of crossbite is considerably smaller than . . . those using more conventional approaches; thus it is possible that we are doing some good.

We are still using these procedures on our newborn and continue to feel that we have a real opportunity to be able to do more orthodontically for these children when they possess a full permanent dentition and are ready for comprehensive treatment.

**GRIFFITH**

In 1977 B. Herold Griffith of Northwestern University, following Clarence Monroe and joining Sheldon Rosenstein, noted the encouraging results he had seen and was getting with maxillary bone grafting. He is following 118 cases, 36 of them more than 10 years postoperative. Evaluation of the cases includes Broad-
bent-Bolton measurements, cephalometric studies, occlusal films and team evaluation. No retardation in maxillary growth and fewer problems with the dental arch are reported. This is the design of treatment: Preoperatively the patient is fitted with a prosthesis by Rosenstein, which is inserted at 2 to 3 months when the lip cleft is closed and the muscle begins to align the segments. At 5 years of age, with minimal undermining and inturning of mucoperiosteal flaps at the alveolar cleft edges, a split rib strut is placed as an onlay subperiosteally across the cleft, a rib block is inserted into the cleft and buccal mucosa is used for cover. In the bilateral cleft, a jackscrew expander spreads the maxillary segments to give the premaxilla a chance to take part in the arch, and then the same method of bone grafting is used. After a wait of six months for bone graft solidification the palatal cleft is closed. Under this regimen, Griffith claims that there is no evidence of attenuation in maxillary growth and there is less evidence of dental deformities previously considered unavoidable.

ROBINSON

In 1969 Frank Robinson and Barrie Wood of Manchester, England, admitted that many surgeons of the United Kingdom considered bone grafting of cleft palate unjustified, the main criticism being that the combined soft tissue and bone grafting procedures took more than the classic hour allowed for such surgery. They noted that with good teamwork the total procedure could be completed in an hour and a half and then reported:

In unilateral cases the results have been impressive in that only three examples of alveolar collapse occurred in 21 cases. . . . Bilateral clefts have presented greater difficulty; orthodontic correction has been more prolonged and less satisfactory and only six cases of the nine in the series were grafted. Three of these collapsed. . . . It will take several years before definite conclusions can be made but our interim conclusions on primary bone grafting are:

1. That collapse of the lesser maxillary segment is prevented.
2. That the lesser segment is brought under the growth stimulus of the nasal septal cartilage and the middle third of the face grows as one unit.
3. That teeth which have formed at the margins of the cleft tend to migrate into the grafted zone.
When this paper was given in Newcastle, George Joss suggested that the good results here might be explained by their accurate two-layer soft tissue closure of the alveolar space as described by Muir.

**M A T T H E W S**

The articulate David Matthews, with Ivor Broomhead, orthodontist William Grossman and Henry Goldin of the Hospital for Sick Children, Great Ormond Street, London, reported in 1970 on early bone grafting in clefts over a seven-year period from 1962 to 1968. The patients were operated on at 3 months of age with the left seventh rib as donor area. The split rib grafts were notched to fit snugly into the alveolar gap and covered with a Stellmach flap. Then small spare pieces of bone were inserted below the alar base. In bilateral cases, which are operated on in two stages at an interval of three weeks, sufficient bone is taken for both sides, and half is stored subcutaneously in the chest wound for subsequent use. When the severity of the projecting premaxilla demands surgical retropositioning, Matthews encourages use of Denis Browne’s “set-back” without concern if bolstered by bone grafts. These authors noted:

Preoperative orthodontics is of great value. . . . But it is not, of course, a passport to certain surgical success.

In 1976 Matthews forwarded this case (A. Position before orthodontics. B. After orthodontics. C. Eruption of teeth. D. Clinical appearance) and included the x-ray films to show the eruption of teeth along the line of the bone graft (E. Rib strut. F. Teeth erupting along the line of the graft). He explained his present stand:
I have used bone grafts in the neonatal period to bridge alveolar gaps for 16 years. A rib is used and it is inset as two struts after separating it longitudinally to increase the amount of cancellous bone exposed. Clearly, an alveolar strut cannot be the answer to the problem of maxillary collapse, but it has a value. It assists greatly the maintenance of the alveolar arch, preventing anterior overlap, and it provides a matrix into which tooth buds bordering the defect can migrate. In my series, this has occurred in 31% of cases. . . . In order to achieve maximum advantage for the alveolar arch, it is necessary to position segments with preoperative orthodontics, so that the lesser segment cannot swing medially on the graft as a pendulum. It is probable that this preoperative manoeuvre has given me much better long-term maintenance of the alveolar arch than other workers have reported. The graft provides maintenance of the alveolar gap as well as the arch, but it cannot, of course, prevent medial displacement of the posterior part of the lesser segment. I have never thought it logical to fill the full length of the bony defect with bone for fear of reducing subsequent growth and expansion through childhood. In every other circumstance, a bone graft is used to cause a solid union and I am fearful of the long-term consequences of rigid union promoted in so young a child.
The university town of Nantes, at the mouth of the Loire River in Brittany, is the site of Tessier's medical school and the home of Jacques Delaire, a fine cleft surgeon. I had heard he was probably the foremost surgeon in France doing primary bone grafting in clefts and wrote to ask his present stand. This is his 1977 response, along with several of his cases showing results three and one-half years after cheilorhinoplasty and primary bone grafting (two stages in bilateral cleft):

1. I have not done any bone grafts since October 1975 (even though I continue to think that in certain cases they improve the quality of results of my operations), for the following reasons:
   — From 1969 to 1975, I adopted your technique of cheiloplasty associating it with a vertical bone graft (in front of the ascending surface of the maxilla), a more extensive subperiosteal dissection, and a primary rhinoplasty.
   — Since that time, I have used a similar technique without a bone graft, with a more extensive reconstitution of the transverse muscles, elevators of the nose and upper lip. The results thus obtained, without grafts, are about the same as those I was obtaining two years ago.

2. My oldest cases of bone grafts in cleft lip are sixteen (16) years old.
3. Altogether, the results that I have obtained with these grafts seem to be better than those where a graft had not been used. The preparation of the bed of the graft accompanied from the beginning by a greater periosteal liberation creating a vertical periosteal sac in front of the ascending maxilla, along with careful reconstitution of the floor of the nostril, may be responsible for some of the improvement.
4. There have been no systematic cephalometric studies, but these patients have been studied by the orthodontists on my service and have been...
treated the moment any problem of occlusion manifested itself. In addition, I have developed a method of posterior-anterior extraoral traction using an orthodontic mask (1972) which prevents certain types of maxillary retrognathia.

5. The primary graft has seemed to me to diminish the vertical and transverse problems of occlusion: cross bite, open bite, and deep bite.

**ALL THAT GLITTERS IS NOT GOLD**

It would seem that to follow the principle of “replace missing tissue with similar tissue in kind—bone for bone, etc.”, early bone grafting of alveolar and hard palate clefts would be indicated. As it has turned out, the answer may not be so simple, and, after a discussion of donor bone, the arguments against early bone grafting will be presented.
18. Choice of Bone and Its Fate

As already noted, first choice of the bone graft donor area is not unanimous. Autogenous is preferred by most over homologous grafts, as stated by Stellmach in 1964:

Experiences with preserved bone were not successful since the bone graft did not survive.

Rib, iliac crest, tibia and vomer all have their champions. Yet there is argument even as to the type of graft and its placement.

RIB

Some surgeons prefer full-thickness while others split the rib and some insist on the addition of chips. David Matthews described a special tailoring of split ribs struts to fit into the alveolar defect. In the young, rib is thin and lean with very little cancellous bone; hence, probably, its reported partial absorption in early primary grafting. In general, costal bone can be spared without undue sacrifice since the rib will regenerate in its periosteal sleeve. With proper instruments, up to 60 cm. of rib, or 120 cm. of split rib, can be removed through a 5 cm. incision. Opening the pleura is a hazard that should occur rarely and can be handled with positive pressure anesthesia. Split rib is a good choice in bone grafting and has stood the test of time. Because there have been problems, including resorption, the work of Joseph Reichman, L. Kerr and L. A. Whitaker of the University of Pennsylvania, studying the fate of autogenous rib grafts in rabbits, is of interest.
The various types of rib graft were inserted into a subperiosteal pocket and the animals injected with vital dyes and then killed and examined. It was found that split rib with the marrow facing bone healed the best. Bone chips (1 mm. in length) were almost completely resorbed. Split ribs with the marrow in contact with soft tissue and full-thickness rib demonstrated poor healing and a high rate of resorption.

**ILIUM**

The crest of the ilium in the young offers poor material, and surgery here is considered by some surgeons a threat to growing centers. Georgiade, Pickrell and Quinn prefer cancellous bone from an area inferior to the iliac crest. They feel:

There is probably more rapid calcification with new bone formation when this type of graft is used.

The ilium offers an excellent source after the age of 10 to 12 years and especially in the adult, but the discomfort and general morbidity have been greater than with the rib.

Hogeman, Jacobsson and Sarnäs of the University Hospital, Malmö, Sweden, noted in 1972 that in bone grafts to the maxilla the use of grafts from the iliac crest instead of from the ribs raised the frequency of successful operations from 34% to 58% and with subsequent addition of a buccal bar ["a spongy bone graft on the buccal side of the alveolar ridge to cover the defect"], to 98%.

In 1974 Schmid, Widmaier, Reichert and Stein expressed preference for compact and spongy layers of hip bone, stating: Rib implants are considered less useful because of the small amount of bone and especially spongiosa obtainable in a small child.

Tessier's method of harvesting iliac bone is described by S. A. Wolfe of Miami, who has used the method more than 100 times without complications of bleeding, infection or contour deformity, and with less discomfort.

The skin incision, about 5–6 cm. long, is made several cm. below the longer incision through iliac crest periosteum. Two oblique cuts reflect the lips of the iliac crest, behind the anterior superior spine, and periosteum is reflected
from inner and outer surfaces of the ilium. Tessier's retractors fit perfectly to expose the central bone which will be harvested, and both cortical plates can be taken if needed. Extra cancellous bone is taken with a curette.

The site is generally drained with a hemovac, and the lips of the crest are wired firmly together. I have begun using a final wire to figure-of-eight these coapted lips to the intact anterior superior spine. A hole is made in the spine with an ice pick-like instrument (Walter Lorenz). The beauty of this method is that the hip is solid, there is no post-op movement of broken bone or torn muscle, and the patient can generally walk the first or second post-op day.

**Tibia**

In young infants of pre-weight-bearing age, a medial, slightly curved incision, as designed by Johanson and Ohlsson, *Acta Chirurgica Scandinavica* 1961, gives excellent exposure of the tibial shaft, offering a large supply (50 cc. or more) of cancellous bone. A cortical segment is removed, and the desired quantity of cancellous bone and marrow can be taken and packed into the cleft. The line of incision, the tibial cortical segment chiseled free to be removed and the bone graft with extra bone marrow are shown. Radiographs of the tibia present the defect two weeks after removal of the graft with periosteal bone formation beginning and healing only three months later. Visible scars and the possibility of a short leg have reduced this donor area's popularity.

**Vomer**

Vomer in the projecting premaxilla has an economic advantage but offers a limited supply. The chance of the surgeon's being overzealous in this quest for bone might result in retropositioning of the premaxilla too far.

**Skull**

In infants and children skull also is a source of bone for grafting. Under the age of 3, complete regeneration occurs even when large quantities of full-thickness skull are taken.
DESTINY OF THE BONE GRAFTS

Of course, the vascularity and functional position of the bed, the type of graft and its size all influence the destiny of the bone grafts.

Manchester of Auckland, New Zealand, stated in Melbourne in 1971:

I claimed many years ago and repeat today, that a bone graft takes and remains just as a skin graft does.

Ivy, paralleling the long life of his bone grafts and in just as good shape, stated in Montreal:

I saw one of my bone grafts the other day at Mount Dora and that is 48 years since it was transplanted! I maintain that once you get the bone graft into good position with a successful take, it will remain there in good shape and without change.

Joss and Broadway of Norwich, England, in 1966 made a three-month tour of European bone grafting centers under the auspices of the Council of Europe and reported:

In many of these centres the grafts, after a while, resorbed in the alveolar region, leaving only a small strut of bone joining the segments at the level of the nasal floor.

They therefore considered that the question of having teeth erupt into the graft had, perhaps, been overstressed.

This was like turning a pair of foxes loose in the chicken coop, and feathers and fur have been flying ever since. Johanson, a fighting cock of the coop, bared his spurs and attacked the intruders several years later:

I want to come back to this report of Joss, which I really thought was a very irritating one, where it was stated that in most of the countries he visited (among others, my own clinic, late at night) the primary bone graft, the onlay graft, just disappeared. I have never used, in my whole series, an onlay graft.

And still later:

It was said by Joss . . . that he never saw a case where the bone graft had survived or remained as a bone graft. All of them were absorbed, he said. We thought this was very funny, because in our series we had never seen a case
like this. We have never demonstrated a case to him, so we wondered where he got this knowledge.

Kriens of Hamburg accepted the challenge but noted that the process of bone grafting was still being improved. He described the evolution of the Schuchardt primary osteoplasty. First, a strong strut was used to hold the alveolar segments apart, but later partial resorption of the graft was seen. As Schuchardt and Kriens noted that small struts had a rare tooth bud making its way into the graft with subsequent alveolar collapse, they were stimulated to increase the amount of bone. As many layers as possible were inserted between the alveolar stumps, and the pocket was filled further with chips. Since transplanted costal bone has no inherent growth potential, intrusion of tooth germs was considered important. In fact, where a tooth bud entered the graft in about three months, resorption of the bone was no longer a problem. Kriens ended with a provocative teaser:

The effort to stimulate regional bone growth by the transplantation of epiphyseal cartilage may add another chapter to the story of primary osteoplasty.

At the 1969 Chicago Cleft Symposium, Colonel Haskell Gruber of the U.S. Air Force referred to his young series of 125 bone grafts:

We find that in a period of 6-8 weeks, the bone graft as such disappears, and then within a period of 12-20 weeks, you suddenly begin to see bone laid down. We feel that the organic salts are removed and the inorganic matrix remains and upon this base new bone is laid down. We have done a great many x-ray studies of these. We find we don’t have alveolar bone . . . we have maxillary bone . . . . Our oldest case is now 4½ years of age, and in the primary dentition, and the bone has remained.

Matthews responded:

I agree entirely with Colonel Gruber that this bone is not the bone that was originally put there. I think the orthopaedic surgeons settled years ago that this is a re-occurrence of bone on a matrix which was provided by the original graft.

In 1964 Stellmach had made a similar statement:

Autogenous bone becomes transformed with the first two years after grafting. The new structure is similar to the neighboring bone.
In fact, as early as 1961 Johanson and Rocker, using microradiography to study autogenous tibial and iliac bone grafts to the palate, contradicted Holmstrand’s 1957 findings that all evidence from study of bone grafts pointed to the replacing bone assuming the same ultrastructure as the original transplant.

Johanson and Rocker found that the excessive tissue of the graft was absorbed and not remineralized. The rest of the graft lost its original structure and was transformed to the same structures as adjacent palatal bone, showing good adaptation of the graft to functional demands.

As his concluding statement during the 1969 Chicago Cleft Symposium, Johanson reported having opened a six-year-old bone graft:

The area where the bone graft was looked exactly as if it was a non-clefted case.

Colonel Gruber then asked Johanson why he advised bone grafting after orthodontics and whether it had been successful with the permanent dentition resulting in good occlusion and arch alignment. Johanson answered:

We feel that when the orthodontist has finished his work and we add bone to the alveolus that you do not have to look at these cases any more from a prosthodontic point of view.

Tom Cronin of Houston, having given some of his bone grafting statistics, suggested that the method of grafting must be important:

When we just put in the onlay graft, we often seemed to have very little bone left later, but by putting in more bone in wedge grafts, the grafts seemed to remain fairly well as shown by repeated x-rays over several years.

David Matthews of London backed Cronin:

My bone graft is only put into the alveolar gap. It is indeed a strut or a wedge. . . . I found in 31.5% of cases teeth growing into the gap. . . . I would think it impossible for a dental follicle to grow into a static, well-established bone plate, but it can and does grow into this new bone, and I can show you pictures of the teeth growing into the bone.
BIOLOGY OF BONE GRAFTS AND FACTORS INFLUENCING THE SURVIVAL

S. A. Wolfe, craniofacial surgeon at the University of Miami, discussed the biology of bone grafts.

Transplanted bone survives. There is no doubt of this to anyone who has had the opportunity to reoperate in an area in which he has previously put a bone graft. Whether or not this is the same bone that was put in is still a matter of debate. It is likely that some of the individual cancellous cells with osteogenic potential do survive (Boyce), but it is also evident that one can put in only the mineral matrix, as in freeze-dried or boiled bone, and eventually have invasion and inhabitation by osteocytic cells. And just as there is constant turnover of cells and collagen in a skin graft, a bone graft is metabolically active and has constant cellular and matrix turnover. A good bit of work remains to be done with radioisotope-labelled cancellous bone to clarify exactly what is happening.

Factors important to maximal survival of the bone graft:

1. First, the type of bone used. There is a higher percentage of take (persistence of the volume of the transplant) with grafts which are largely cancellous, as opposed to cortical. Thus, a higher portion of an iliac graft can be expected to survive in comparison with a rib graft, since a larger portion of it is cancellous.

2. The bone graft must be solidly affixed to the recipient bony area. Grafts that are subject to motion at their point of contact with recipient area bone seem to fare worse than ones which are solidly wired in place. Split ribs in the infraorbital area do better if wired to the infraorbital rim, compared to those which are just laid in place; nasal bone grafts which allow some wiggle are often the ones which will have to be redone. There is some experimental evidence that split ribs do better if a layer of periosteum is left on the outer surface (but then the donor area will not do so well), and the cancellous surface placed against abraded donor bone, than if any other combination is used.

3. There should be coverage of bone grafts by periosteum if possible, and then cover by adequate amounts of soft tissue, not under great tension. If bone grafts are placed free in soft tissue, almost complete resorption can be anticipated. Considerable resorption also occurs if bone grafts are subject to pressure from tight, inadequate soft tissue cover.

4. The size and number of foreign bodies present should be minimized. It may take more skill in carpentry and ingenuity to obtain solid fixation without the use of screws, mesh trays, and cumbersome orthopedic plates, but these types of hardware interfere with vascular contact with the graft,
provide a nidus for infection, and are against basic principles. Solid fixation can generally be obtained with a few properly placed wires, interlocking "autoretentive" bone fixation, and occasionally a small Kirschner wire. If extrinsic support and fixation is required, it is better to use a few percutaneous screws in normal bone on either side of the bone graft, and then bridge across externally with acrylic.

5. Finally, in human beings there seems to be a "critical mass" of bone graft, even fresh, autogenous, cancellous, that can be expected to survive under the best of circumstances. A bone graft can exceed one cm. on two dimensions, but not three. If larger amounts of bone than this are required, surgery must be staged.

The difficulty obtaining adequate amounts of donor bone, and the pain and deformity often associated with taking bone in the past, have led to many efforts over the years to find an acceptable bone substitute: the evolution has been from ivory to Kiel bone to bank bone among biological materials, and from acrylic to silastic to proplast among synthetic materials. Certainly, there have been reported successes using all of these substances, but the failure rate is still high compared to fresh, autogenous bone, and the patient continues to be at risk from infection and rejection long after the procedure, at a time when the autogenous bone would have been incorporated into the skeleton and have the same defense mechanisms as normal bone.

Until the basic transplantation barriers are eliminated, as they eventually will be, efforts should certainly continue in developing and perfecting ways of taking autogenous bone, with as little difficulty, pain and deformity as possible.
19. Increasing Uneasiness among the Bone Grafting Troops but Increasing Interest in Late Grafting

This impressive Germanic gathering in front of the Royal College of Surgeons, London, in 1959 during the Second International Congress, is composed of various palate experts. From left to right are Steinhardt, Rosenthal and Trauner, and on the other side are Schmid, Schuchardt and Rehrmann. All are obviously still quite happy about early bone grafting. Yet against the almost arrogant avalanche of surgeons grafting bone primarily into alveolar clefts, there began to appear a scattering of skeptics even among the surgeons themselves.

Pruzansky's Dissent

In 1963 at the convention of the American Cleft Palate Association in Washington, D.C., orthodontist Samuel Pruzansky leveled a provocative dissent from presurgical orthopedics and bone grafting implants in cleft lip and palate. He launched his attack by accusing an army of surgeons buttressed by orthodontists and prosthodontists:

Their battle cry is a cabalistic mumbo-jumbo invoking the mystique of embryology and growth and development.

Instead of research with documented results, he claimed,
We have been fed opinion, anecdotal pap, wishful thinking, and empirical trivia.

He gave as the basis of his dissent a longitudinal growth study of children with cleft lip and palate begun in 1949 involving casts, roentgenccephalometric, laminagraphic and other measures on more than 1,000 children from the time of their birth and explained he had no motive to support or fault any philosophy or method of therapy:

The only objective is to report the facts as they are!

and

Not all clefts are alike!

In a large series of complete unilateral clefts of the lip and palate, Pruzansky found 37 percent without crossbite and 40 percent with complete buccal crossbite on the affected side. The rest showed varying degrees of incomplete crossbite.

Since a significant number of patients do not develop cross-bite at all, is there justification for treating all patients by presurgical maxillary orthopedics and bone grafting?

He answered his own question:

In our judgment, there is none. Moreover, the malocclusion present in the preschool child can be readily, quickly and less expensively treated by simple expansion procedures.

He summed up the arguments for and against bone grafting:

**For.** Mesodermal deficiency.

**Against.** A static concept that does not allow for change as a function of growth and development.

**For.** Prevents malocclusion.

**Against.** Many cases do not need orthodontic treatment. The majority can be treated by conventional procedures.

**For.** Closes off anterior fistulae. Binds the segments and prohibits their orthodontic manipulation at a later age.

**Against.** Produces and maintains excessive width of the cleft posteriorly, a disadvantage to velopharyngeal reconstruction. Potentially hazardous operation (pleural puncture, pathological fractures of the tibia, scarred leg) not warranted for an elective procedure of dubious merit.
Pruzansky noted with irony that nearly the same reasons invoked by Brophy for jaw-compression now seem perfectly suited to justify jaw-expansion.

In 1923 Brophy had been convinced that an adult, growing up with a cleft palate, has not the full complement of tissue . . . as it has not been subjected to the uses for which it was intended. Besides, the tuberosities spread which contributes to the shortening of the palate.

But the error of Brophy's reasoning stemmed from his erroneous interpretation of the consequences of cheiloplasty in complete unilateral clefts:

Following closure of the cleft lip, the alveolar borders of the anterior extremity of the cleft, by reason of traction of m. orbicularis oris, gradually approach each other. . . . The malar bones act as pivots and the posterior processes, the tuberosities, move farther apart, and the cleft is widened.

Thus, on the basis of the "abnormal separation of the tuberosities" fallacy, Brophy formulated a method of approximating the separated bones prior to the closure of the lip.

Pruzansky argued that collapse of the arch can be treated easily with rapid, complete and inexpensive correction. To the claim that excessive medial movement of the maxillary segments . . . is an undesirable side effect of cheiloplasty and therefore should be prevented.

Pruzansky countered with collapse of the arches may be regarded as desirable in that it facilitates velopharyngeal reconstruction. Pre-surgical orthopedics inhibits such collapse and thereby may retard velopharyngeal correction at an early age.

Finally, the provocative Pruzansky took a sword swipe at the German orthodontists, devoted to promoting growth by profoundly stimulating development, for providing soil in which pre-surgical orthopedics and bone grafting can take root and flourish.

In a dare worthy of a duel, he challenged them:
Instead of expending their energies in understanding more about the natural post-natal development of cleft lip and palate, they continue in search of the prosthetic or surgical touchstone that will transform cleft palates into normal palates overnight.

A Pruzansky conclusion:

When the adult dentition has erupted, and orthodontic treatment is completed at about age 13, then it becomes possible to determine whether that individual is indeed deficient in tissue mass at the alveolar process. In such instances, [1] endorse bone grafting. However, such cases seem to be in the minority.

At a social gathering in Pruzansky’s suite during the 1963 international meetings, Owsley recalled that the “new” early bone grafting of the maxilla came into the conversation. Husky Bengt Johanson, a stalwart advocate of primary bone grafting, who often looms even larger than he is, got into a confrontation with feisty little Sam Pruzansky. They lined up eyeball to eyeball (Sam was standing on his bed) and Sam snarled to Bengt:

It won’t work!

This was a prophecy.

SKEPTICISM OF THE ORIGINATOR

It is important to realize that E. Schmid, the surgeon who initiated maxillary bone grafting in the early 1950’s, voiced skepticism when he wrote:

Besides, no experience is yet available to determine whether this procedure will be able to improve the results of cleft surgery. The procedure has merely been presented for discussion.

In his 1964 Gillies Memorial Lecture, Francis Burian of Prague questioned the value of the popular early bone grafting:

There is no doubt that this operation has a logical basis, for the graft supplies the bone tissue to fill in the defect, which is more or less extensive in total clefts. However, I have some doubts about this operation. A bone-graft must be applied to denuded bone. To lift off the periosteum of such young bone is a very delicate operation, especially on the poles of the
cleft, which are most important for the further growth of the maxilla. We must bear in mind that the growing potency of the parts of the maxilla is already weakened in clefts and additional harm may be caused, the consequences of which would appear only after many years. Besides, a bone-graft requires a safe and reliable bed in which it would be perfectly covered. In my opinion, there may be difficulties in achieving this. The taking of the graft itself undeniably imposes a further strain on the infant. . . . Results will become open to criticism only after at least ten years. Of course, in the case of an older child with a reconstructed lip, where all conditions are favourable, there is no objection to secondary bone grafting.

AN EARLY BONE GRAFTING LEADER BALKS

Johanson concluded in 1964 at the Hamburg Symposium that

The primary bone grafting in our hands has not prevented the bite to develop similar to what you will find in carefully treated series without bone grafting. The orthodontic correction of the deciduous bite has, however, been easy to perform, and the stabilization of the premaxilla in the double cleft cases has been of unquestionable value. As a result of our findings, we have now started a new series with every second case treated primarily and in the rest the bone grafting will be postponed until the time of the second dentition.

In 1964 S. Pruzansky and in 1964 and 1967 S. Pruzansky and H. Aduss compared the results achieved at Illinois without presurgical orthodontics and early bone grafting with those from Goteborg reported by Kling with presurgical orthodontics and bone grafting. The comparisons suggested, they felt, that Kling's findings were indeed much worse than those achieved by "less modern" methods, and Kling seemed to concur:

From the point of view of the bite, the results do not seem, at a glance, to differ much from those achieved earlier with less advanced methods of treatment.

In 1965 Johanson, in the Northcroft Memorial Lecture, reviewed over 100 cases treated with his early bone grafting during a 10-year period. The results were so disappointing, he concluded, that he had discontinued this method of treatment. Since 1968 his order of treatment has been changed to: first, a lip adhesion;
at 1 month, closure of hard palate with vomer flap; at 6 months, closure of soft palate; and at 18 months, closure of lip. Only at 12 to 18 years does he bone-graft the alveolus and hard palate. This is his regimen today.

Johanson is a vigorous Viking from Sweden who is intolerant of nonsense and smashes through mincing opposition. His favorite relaxation involves five to six hours of rowing in a small boat to Roslagen in the Baltic Sea. Carrying a 9 mm. rifle in a watertight tube, he slides out of the boat, wades through icy water and climbs onto rocks from which he can shoot 200 pound seals and lift them up onto land for skinning. He considers 10 to 15 a good day’s haul and reports that the meat is delicious, particularly the liver. I have seen him handle opposition in a congress as if he were shooting a seal—and in English, no less!

At the Second International Symposium on “The Early Treatment of Cleft Lip and Palate” held at Northwestern University Dental School in April 1969, Sheldon Rosenstein of Chicago’s Children’s Memorial Hospital, in response to the banter of those for bone grafting and those against it, asked for proof of good results at age 14 to 15 years by conventional methods. Chairman Richard Cole of the Lancaster Cleft Palate Clinic repeated a valuable refrain:

It strikes me again, however, that our concern is and should be making sure that we are now accurately and adequately documenting our treatment results through accurate measures.

This brought Bengt Johanson to his feet!

Yes. . . . I would say that that which started us with primary bone grafting and the new thinking of combining bone grafting with early orthodontic treatment was that results in the early soft tissue repair were not good. . . . We found when we had had about 10 years’ experience with primary bone grafting, that our results were much better and so we were very pleased. . . . Then these cases changed from the primary dentition, and we found that we really hadn’t gained that much. . . . Everyone here has shown different series of cases, some with orthodontics combined with bone graft, some with orthodontics without bone graft, and some with soft tissue repair only. We have seen that all of us can show very nice results depending on the given case. . . . I can show you beautiful cases with a bone graft, with teeth coming down into position and how with orthodontic treatment
the permanent dentition looked good. But I know in documenting the
series which now parallels the bone grafted series that our results are much
better today, without the primary bone graft, than they were when we
started.

I still say that the bone graft will have a place, in the end, in the final
handling of the total cleft. But everyone here is saying, "I just started; I want
to find out, in my own group, whether primary bone grafting is good or
not." For God's sake, go back and look through everything that already has
been done. We don't have to go back and do these things all over again in
every little unit in the world. We can use the publications and the informa-
tion we have; we can rely upon each other.

In his latest follow-up study of children treated with primary
bone grafting, Johanson, with Hans Friede in 1974, concluded:

In spite of the inherent fault of small numbers of patients and no actual
controls these intermediate data on the effect of primary bone grafting point
to the conclusion that this method did not result in the expected normalisa-
tion in the growth of the middle face and the jaws. On the contrary our
results seem to be inferior to those reported for cleft patients subjected to
neither early jaw orthopaedics nor primary bone grafting.

The bone graft of the anterior maxilla healed in every instance but it
resulted in an abnormal maxillary development with increased frequency of
both lateral and anterior crossbites.

The local and general maxillary growth retardation gave our cleft patients
a pronounced maxillary retrognathia which increased with age. When full
grown, the facial profile of our patients will frequently be concave; in many
cases to such an extent that we cannot recommend primary bone grafting.
In our Center this treatment method has not been carried out on cleft
infants since 1964.

Also in 1974, Bengt Johanson gave a follow-up on his sec-
ondary bone grafting. He had 125 cleft patients (21 bilateral and
104 unilateral) with the mean age of 20 years at the time of bone
grafting. The follow-up interval after bone grafting varied from 3
to 14 years (mean interval 7.5). Ninety-three patients were
available for final evaluation; with the exception of six of these,
all had postoperative orthodontic treatment.

At surgery, particular attention was paid to the filling of the
cleft in the alveolar process and hard palate. For at least one year
after surgery, a removable retainer was used until permanent
prosthetic construction had been completed.
The bone grafts healed in 96 percent of the cases. In 12 patients pinhole-sized fistulae remained. A slight degree of relapse after orthodontic treatment was noted. The cephalometric values indicated maxillary as well as mandibular retrognathia. Even if many of the patients showed straight or slightly concave facial profiles, normalization of the anterior occlusion had occurred by means of the moderate retroclination of the lower incisors without overexpansion of the maxilla.

It was concluded that bone grafting of the alveolar process, and the palate in the adult, normalized and stabilized the maxilla in practically all instances.

**DERICHWEILER AND OTHERS**

In 1958 Hans Derichsweiler of Munich reported early orthopedic treatment before bone grafting. At the Hamburg Symposium in 1964, it was reported that Derichsweiler found 90 percent severe malocclusion after bone grafting in 30 bilateral clefts at age 6 months. His cases without grafting revealed a similar percentage of malocclusions, which led him to conclude that bone grafting may have other merits but the prevention of severe malocclusion is not one of them.

In 1965 J. Chalmers of the University of Liège reported work on growth of grafted bone, showing that bone grafts reveal virtually no capacity for growth unless they are subjected to great stress. Only bone transplanted with a cartilaginous growth center will show growth.

In 1966 P. Baumgartner and B. Maeglin questioned the possibilities of detrimental late results following early osteoplasty of the cleft alveolus. They wrote:

> Since a graft does not ordinarily follow body growth after transplantation, it would be conceivable that ossification of the cleft could invite impairment of growth of those bony parts in the cleft area joined by the transplant.

In 1967 S. Stenström and B. Thilander of Umeå University, Sweden, reported experiments with bone grafting in guinea pigs. Half of their animals had excision of the maxillopremaxillary suture followed by insertion of an iliac bone graft. Growth was studied by radiographs and subsequent examination of the skulls.
The cleft but ungrafted jaws grew symmetrically and equally compared with normal controls. The skulls of the grafted animals were asymmetrical and showed limitation of growth.

The dynamic Kenneth L. Pickrell of Duke University, who trained with the pioneer John Staige Davis at Johns Hopkins University Hospital from 1937 to 1940, recalled that time as the era of ether and horsehair. In 1968, with G. Quinn and R. Massengill, he gave a typical no-nonsense evaluation of 25 infants followed for a minimum of four years. Although partially conflicting with the findings of others, they summarized their stand quite bluntly:

1. Primary rib grafts in the maxilla do not increase in size concomitant with facial growth and development.
2. Teeth do not migrate and erupt spontaneously through a rib bone graft.
3. Rib bone grafts do not form a true alveolar process; a permanent alveolar notch remains.
4. The orthopedic effect of the bone graft decreases as its incorporation increases.

The late J. J. Longacre of Ohio, long devoted to his favorite sport of splitting ribs, might have been expected to jump at the chance to insert a few of his grafts as early as possible. Such was not the case, for in 1970 he indicated reservations at least in the time of the bone grafting. His recommendation for patients with a bony deficit follows: An early retainer is to be used until deciduous teeth erupt, when an expansion appliance is in order. At 4½ to 5 years, a bone graft with split rib is inserted, and the maxillary segments are maintained in position until the bone graft is consolidated. Six months later, a V-Y palate closure is followed by further maintenance of expansion until molars erupt.

**REHRMANN CALLS A HALT TO EARLY BONE GRAFTING**

A most important result, because of its status as the study with the longest chronological interval between surgery and reexamination, was presented by Rehrmann, Koberg and Koch at the
International Cleft Palate Congress in Houston in 1969. The able and untiring Alfred Rehrmann, a classical musician and violin maker, was a student of Wassmund in Berlin for three years. He then became an assistant to Schuchardt in Berlin, served in several maxillofacial units during World War II and finally rejoined the dogmatic Schuchardt in Hamburg for seven years. Having been regimented in the ways of the Hamburg primary osteoplasty, Rehrmann carried on this work, but with comparative controls, when he became professor of the Westdeutsche Kieferklinik, University of Düsseldorf. With Koberg and Koch, he evaluated and analyzed statistically the long-term follow-ups of primary and secondary bone grafting in infants and small children over a 10-year period. Two groups consisting of 50 children each were compared. In the bone-grafted group, 40 children had a primary osteoplasty, 34 percent with a Stellmack flap. The other 66 percent had a surgical procedure using Veau-Axhausen for the nasal lining and Burian-Trauner for the oral lining. The remaining 10 children were grafted secondarily at a mean age of 4.5 years. In the control group the alveolar cleft was closed according to Veau-Axhausen, but in 16 percent a simultaneous Pichler flap was used to close the hard palate, while in 84 percent the mean age at hard palate closure was 4.5 years. All the subjects had LeMesurier lip closure. Forty-seven percent of the bone-grafted group had orthodontia as compared to 48 percent of the controls.

Bite relations in all three dimensions of those cases in which the Stellmack tilted vomer flap or the septal mucosal flap of Pichler was used were not worse than those using the Veau-Axhausen method. Rehrmann concluded:

The use of a very great part of the septal mucosa does not influence the forward directed development of the maxilla.

After comparing the bone-grafted cases with those without grafts, Rehrmann drew further conclusions:

Bone grafting in the area of the alveolar processes does not bring about permanent stabilization of the segments. Lengthening of the bony bridge was never observed. . . . Contrarily, the inserted bone becomes shorter over the years. . . . The frontal ends of alveolar processes conjugated by bone are
rather retarding in their development in all three dimensions. . . . The resulting bony bridge . . . keeps these ends of the alveolar segments together comparable to a claw. . . . Malocclusions of grades 2 and 3 in the sagittal and horizontal planes were prevalent in the grafted group in high significance in comparison with the ungrafted group. Therefore, it must be concluded that early bone grafting in nearly all of our cases provokes retardation in development of the maxillary arch and local growth arrest of the maxillary bone. For that reason, we have abandoned primary and early secondary bone grafting and limit osteoplasty to the time after secondary dentition.

After over 40 years' experience, he wrote in 1971:

We must confess that the disfigurations mostly are the consequences of the surgeon's work. To unite the segments in a very early age means to connect the segments—more or less—by a bar of scar tissue hindering the tiny baby's maxilla to expand to an adult width and form. In addition: damaging of tooth germs, depriving the segments of their periosteum, especially of its anterior ends, brutal "realignment" for achieving an instant normal shape, and last, the bridging of the cleft by means of bone transplantation are highly responsible for the undesired results.

My compromise is as follows: . . . bridging of the alveolar and palatal part of the cleft should be made with the cranially pedicled mucosa of the septum by tilting it over the cleft and incorporating its edge into a pocket. The anterior ends of the segments should never be touched or denuded. The premaxilla should never be repositioned by surgical means. . . . The remaining velar part of the cleft is closed at 2 years utilizing bridge flaps and elongation of velar mucosa by Z-plasties.

At the 1969 Cleft Palate Symposium held in Chicago, foxy Mazaheri of Lancaster challenged Cronin of Houston, known to have championed early maxillary bone grafting:

Dr. Cronin, you mentioned that you had 11 bilateral cases and that out of the 11 you had 8 who had crossbites in terms of maxillo-mandibular bite. Are you saying to us that this is a good result, or a fair result? Does this show that you are achieving a better result in terms of maxillo-mandibular relationships as compared to those which most of us show without any early bone grafting or orthopedic therapy?

Cronin responded:

No, aside from stabilization of the free-floating premaxilla, I think that is the only part that is really good. As to the rest of it, I don't think it is any
better. In all our cases the orthodontist has been able to achieve a good occlusion, but whether we have helped him any by these early procedures is open to question.

Mazaheri countered:

I believe in our experience that the major difficulty with these patients has been the scar tissue which is created by denuding the bone.

This comment reopened the "old wound" about the consequences of maxillary wounds and the subject was met head-on by Johanson:

I think the healing process that you get when you resurface that denuded hard palate with secondary epithelium is not a type of scar tissue in the same respect as the scarring of raising a mucoperiosteal flap and replacing it, which is followed by scarring and shrinkage.

David Davies of South Africa concurred:

It is a great mistake to compare the scarring of skin and scarring of a denuded area inside the mouth which behaves in a different way . . . and 14 days later, the whole anterior palate is healed. . . . It is hard to imagine that a large amount of scar tissue has been laid down, since the healing period is too short.

Skoog, in his 1974 book, noted the animal research of Engdahl and Hellquist and pointed to the deformity developing after subperiosteal maxillary resection and bone grafting. He concluded:

This investigation clearly demonstrates, that within a standardized maxillary defect, the bone produced by bone grafting behaves quite differently during growth than the bone which regenerates from a periosteal lined cavity that has been filled with blood. These observations may well explain the unfortunate results of primary bone grafting in infant clefts.

He then summarized and condemned early bone grafting with three sentences:

To restore maxillary continuity bone grafting techniques were implemented at early ages (Nordin and Johanson 1955, and Schmid 1955). Bone positioned in this way, though providing immediate stability, did not develop with the child (Thilander and Stenström 1967, Friede and Johanson 1974, and others). When retardation of facial growth became apparent this method of treatment was widely abandoned.
Pediatric surgeon Ambrose Jolleys of Manchester recalled in 1977:

At the Royal Manchester Children’s Hospital, I worked with a general surgeon who then did the cleft lip or palate work and I became involved deeply in this depressing subject. I was concerned about the possibility that the surgeon aggravated the problem by his surgery and became interested in the possibility of pre-operative orthodontic procedures. After more training under Sir Denis Browne and David Matthews at Great Ormond Street, I returned to Manchester and with Professor Robertson have tried to evaluate the place of bone grafting and correct timing of palate surgery.

In 1972 Jolleys, with N. R. E. Robertson of Cardiff, reported a five-year study of early bone grafting in complete clefts of the lip and palate. At 3 months, after presurgical orthodontic treatment, closure was achieved for the lip, the anterior palate with a mucosal flap and the soft palate with a Wardill two-flap method. A retention plate was inserted until 11 months, when the hard palate cleft was closed and the plate returned until 21 months. In the experimental group, split rib grafts were fitted horizontally into the alveolar gap and surrounded by chips between the ages of 12 and 15 months.

No clear advantageous result could be detected in the grafted group. A notch remained in the cleft area and the grafted bone was insufficient to support a tooth in normal position.

On the other hand, limitation of growth occurred in the upper jaws in the graft patients and was manifested by reduced antero-posterior development, an increased incidence of crossbite, and a reduced area of upper jaw.

Evidence is presented that this deleterious effect became worse between the 4th and 5th years of age, and appears to be due to the presence of bone.

Bone grafting in young patients has been abandoned.

In 1972 Karl-Erik Hogeman with S. Jacobsson and K. V. Sarnäs of Malmö reported a follow-up of 145 cleft patients after secondary bone grafting. In some of the early bone grafting, they noted, the operation was successful, but clinical and radiographic review showed a deepening of the groove, indicating that the growth of the graft had not kept pace with the adjacent alveolar bone. They concluded:

Today we refrain from early operations . . . and now do not operate on patients below 12 years. In our experience, secondary repair with bone graft
has proved a safe and effective method for securing stable occlusion with improved lip appearance.

Charlie Horton of Norfolk, who had shown an interest in primary bone grafting, wrote in 1971:

Even if bone grafts do not prevent collapse, they help improve the nasal contour, the tooth environment and provide a symmetrically growing base for the child. I never was a proponent for a primary bone graft, and I still feel that bone grafts in later ages are worthwhile.

In 1973 Franz Härle and Jürgen Dürker of the University of Freiburg, West Germany, following comparative clinical investigation of children with unilateral clefts, found worse occlusion in the group with osteoplasty. Animal model tests in young inbred rats showed that the growth of the maxilla was significantly hindered if a bone defect similar to a unilateral cleft was simulated. Maxillary growth was severely, and in a statistically significant manner, impeded if the defects were filled with autogenous bone grafts. From clinical follow-up and animal experiments they concluded:

The logical consequence of our investigations is to abandon primary and early secondary osteoplasty. . . . The only possible osteoplasty in cleft surgery is a late secondary osteoplasty. . . . The operation should be done after the second dentition and after development of the mid-face, i.e., after the age of 15 years.

In 1973, at the International Congress on Cleft Palate in Copenhagen, Wolfgang R. Koberg of the Rhinisch-Westphalian Technical College, Aachen, West Germany, renounced emotion and passion during discussion of early bone grafting and promised to discuss it purely factually, fairly and tolerantly. His last paragraph was pithy:

The first, and unfortunately to date the only exact report on late results following primary and early secondary osteoplasty in the cleft alveolus was made on the basis of a large group of patients and confirmed with statistical data and presented in Houston in 1969 (Rehrmann, Koberg and Koch 1970). In this oldest and (with 70 bone grafts) the largest group, it was possible, by comparing alternating rows, to show that after bone grafting in $X^2$-test, moderate and most severe dysgnathia predominated highly significantly in
the sagittal and transverse directions on the side of osteoplasty in children. We have incriminated our osteoplasty for these alarming results of iatrogenic arrest of maxillary development, and have therefore abandoned primary and early secondary bone grafting. Similar decisions were also taken by Hollmann (1964), Hollmann and Tomasoni (1965), Perko (1966, 1969), Manchester (1969), Mazaheri (1969), and Hogeman and Jacobson (1972). The cited disappointing late results were consequent upon osteoplasties which were achieved according to the principle of the Dusseldorf group (Rehrmann 1964, 1967, 1971; Schrudde and Stellmach 1958, 1959, Stellmach 1958, 1959, 1960, 1963, 1964, 1965, 1966, Schmid 1967). We have been waiting for the past 5 years for the late results of other large cleft centres (Hamburg and Stuttgart) (Koberg and Veneziani 1969), in order to make a definite statement as to whether it is only a question of difference in operative technique (Pfeifer 1972) or whether the grafted bone does actually hold the anterior ends of the segments together like a claw and thus stifle their intrinsic growth potential (Koberg 1970). Our long-term results were recently fully confirmed by Härle (1971) on the basis of extensive clinical investigation and additional animal experiments. Consequently, most severe maxillary deformities are to be expected as late results of primary bone grafting, so that late secondary osteoplasty remains as the only justifiable form of bone transplantation in cleft surgery.

BONE GRAFTING AT 5 YEARS

Impressed by his observations in India, that

the maxilla of adult cleft patients who had not been operated upon showed normal growth and form,

Wilfried Schilli of the University of Freiburg, West Germany, began a research study. At the 1973 International Congress on Cleft Palate in Copenhagen, Schilli, with G. Komposch and G. Munker, reported a study of 34 complete cleft palate cases in which rotation-advancement of the lip and Veau closure of the nasal floor were done at 3 months, Campbell closure of hard palate and Schilli modification of Widmaier method for the soft palate at 3 years. At age 5 with the aid of orthodontia when necessary, the arches were symmetrical. At this time half of the patients had their alveolar arches stabilized with autogenous pelvic bone grafts. First comparative study at 7 years of age revealed a slight tendency to underdevelopment of the entire
maxilla in all three dimensions, and deviation of the middle line to the grafted side was significant. At age 9 there was more evidence of disturbance:

90% need orthodontical treatment whereas the control-group after the Vomer-flap-operation only in 14% need orthodontical treatment.

Stellmack of Berlin noted in 1976:

Primary bone grafting in the average case did not show permanent improvement of the late orthodontic results nor could the necessity for later orthodontic treatment be minimized as expected beforehand. With the exception of severe hypoplasia, we postpone bone grafting to the end of the second dentition and maxillary growth.

In 1965 J. B. Lynch, Steve Lewis and Truman Blocker of the University of Texas, Galveston, reported 92 cases of maxillary orthodontics and early bone grafting. They commented:

The value lies not only in stabilizing the maxillary arch and in orthodontic correction, but in providing a mass of bone into which permanent teeth may migrate spontaneously or may be moved orthodontically.

By 1977 J. B. Lynch, now at Vanderbilt University and occasionally enjoying flushing dove, duck and quail from the Tennessee bush was expressing second thoughts:

During the wave of enthusiasm for early maxillary bone grafting in the early sixties, I was involved in over 300 cases. Follow-up of these patients has indicated that presurgical orthodontia and bone grafting has not uniformly prevented maxillary arch collapse, nor has it eliminated conventional orthodontic treatment. The bone graft itself tends to become quite thin and attenuated in the majority of patients. With the exception of an occasional bilateral cleft with a very unstable premaxilla where stabilization with bone graft might be of some benefit, I do not believe that maxillary arch repositioning and bone grafting in infancy accomplishes anything that cannot be better done when the child is older. I do, however, feel that the earlier orthodontic involvement in the care of these patients has had a beneficial impact.

Howard Aduss, orthodontist at Abraham Lincoln School of Medicine, University of Illinois at the Medical Center, Chicago, threw a staggering block against primary bone grafting at the Cleft Palate Symposium at Duke University in 1973. He summarized:
It would be remiss to omit an assessment of the current status of presurgical maxillary orthopedics and bone grafting. On the basis of reports by Rehrmann and co-workers after a five-year follow-up and Jolley's and Robertson after ten years, it appears that presurgical maxillary orthopedics continues to be employed to align segments to facilitate repair of the lip, but bone grafts have not provided the stabilization that has been hoped for; bone grafts have not decreased the prevalence of crossbite; and the grafts have provoked retardation in the development of the maxillary arch and local growth arrest of the maxilla. As a result of their findings and those of others, both Rehrmann and his group and Jolley's and Robertson have abandoned the use of primary bone grafts for infants and children.

EARLY BETTER BUT LATER BEST

At the International Cleft Palate Congress in 1969 in Houston, Bill Manchester of Auckland, New Zealand, accused bone grafters of having all been led up a blind trail.

David Matthews of London, at the Second International Symposium on Early Treatment of Cleft Lip and Palate, held later that same year in Chicago, took Manchester's stand to task:

This seemed to me to be a most improper remark, however well-intentioned it might have been.

He continued to defend his own position:

The best craftsman that I have ever seen in this work was Tommy Kilner, and I spent a good deal of time as his junior. But as time went by I spent a good deal of time trying to correct some of the quite disastrous consequences of some of the most beautiful operations that he had done. Consequently, I am most reluctant to agree that if we went back to these early methods we would get better results than they did. At any rate, for these reasons, in 1960, I started doing early bone grafting.

Matthews spent several years experimenting and modifying. Always in the front line and with great technical skill himself, he probed the possibilities of early versus late bone grafting. In 1970, after seven years of experience, he reported, with Broomhead, Grossman and Goldin, his results.
Preoperative orthodontics was begun within the first two to three weeks of life. In severe premaxillary protrusion, a Denis Browne type of setback was used. Matthews feels that the end result was not prejudiced by this radical operation provided the setback was backed up by bilateral bone grafts. In his early grafts, notched split rib grafts were inserted at 3 months of age into the alveolar gap in front of a Stellmach flap, small spare pieces being placed below the alar base. The survey included 84 cases with radiographic evidence of bone graft survival in 88 percent and teeth moving into the area of the graft and erupting in 31.5 percent. Perfect occlusion was found in 13 percent, perfect occlusion after minor orthodontics in 47 percent, failure resulting in maxillary collapse in spite of evidence of the bone graft in 14 percent and small arch requiring further surgery in adolescence in 25 percent. Possibly seeing the handwriting on the wall, Matthews wrote:

If primary bone grafting is ultimately abandoned, it will be because the long-term results do not justify it; not because of technical hazard.

ENTHUSIASTIC ABOUT LATE GRAFTING

In the late grafts the technique of “rapid expansion followed by bone grafting” was used as first reported at the International Congress in Washington, D.C., in 1963 by Matthews and orthodontist William Grossman. Sectional cap splints were applied to the parts of the maxilla and connected by a Fischer expansion screw set in acrylic. In unilateral clefts, a single screw was set transversely to expand the two segments; in bilateral cases, a second screw was set at right angles to the first to move the premaxilla. As Matthews remarked:
The secret of orthodontic success is the rapidity of the expansion.

Expansion was completed in two to three weeks with a turn of the screw three times a day. The segments were slightly overexpanded in younger patients in whom growth was not complete. Following expansion, a thin graft of iliac bone carrying perios­teum was wedged well down into the alveolar gap between nasal and buccal mucosa after closure of any preexisting fistula.

The bone graft extended back the full length of the hard palate and forward to support the alar base. The extension apparatus was maintained for seven weeks for consolidation of the graft, then a removable appliance was used for three months and finally a denture or fixed bridge was fitted. Although the first cases were undertaken at 10 to 12 years of age, Matthews in 1976 preferred to wait until 18 with the intention of setting the maxilla in occlusion with the fully developed mandible for permanent adult relationship.

Where rapid expansion and bone grafting failed to obtain normal occlusion because of retroposition of the maxilla, maxillary osteotomy was advocated six months after insertion of the graft. This action involved section of septal bone and cartilage close to the nostril floor and division of the pterygoid plates and lateral maxillary walls at the level of the antral floor.

Of the 55 cases, 74 percent have remained in perfect occlusion and 15 percent have shown only minor degrees of lingual occlusion. In 10.5 percent there has been relapse, and thus these were considered failures.

In 1976 Matthews reviewed his position on rapid expansion in the teenage patient and included this case example:

Bone grafts are still used in cleft cases to maintain the maxillary segments in correct occlusion in a teenager, after rapid expansion with segmental cap
splints and distraction screws. The object of this operation is to restore the collapsed maxilla, after growth has taken place, by producing solid bony union through the full length of the bony defect. In 1969, I reported 50 successful cases out of a series of 55. In 1974, I reexamined the successes and have found that the position has been maintained.

It seems, therefore, that it is reasonable to claim that this procedure does restore permanent normal occlusion. An important additional benefit is the restoration of a patent airway.

In 1972 Norman R. E. Robertson of Cardiff and J. Fish of Manchester reported their experience with 40 cleft patients, 8 of them bilateral, who had had the clefts closed in infancy. Forty-eight bone grafts following rapid expansion technique of Matthews had been carried out between the ages of 3 years 6 months and 11 years 6 months, by means of cap splints with expansion screws and rib bone grafts. Robertson and Fish concluded:

1. Later bone grafting after preliminary rapid arch expansion does not prevent collapse and the recurrence of crossbite in the buccal segments.
2. The degree of collapse occurring may be related to the tension in the soft tissue of lip and cheek.
3. Over expansion might prevent relapse occurring but it is suggested that the method described is of limited value when considered in relation to the production of a better occlusion.
4. The later bone grafts remain *in situ* and do not cause interference to the antero-posterior growth in the maxilla. This may be related to the fact that not a great deal of antero-posterior growth is occurring at the ages studied.

They acknowledged:

This is contrary to the claims made by Matthews and Grossman for their series.

**BONE GRAFTING AT 12 YEARS**

In 1977 at a Cleft Symposium in Chicago, John Owsley of the University of California, recognizing the difficulty of early bone graft *take* and *expansion*, advocated maxillary bone grafting as a later stabilizing effect. At 12 to 13 years, when the patient is unwilling to wear a retention plate any longer and hence promises a propensity for crossbite, he advocates insertion of a bone graft. Using a split rib, a cortical wedge inserted into the cleft along with packing of cancellous chips, he constructs his stabilization of the maxillary arch. This is splinted with a lingual arch wire with spring expansion to throw stretch stress on the bone graft.

**PRESENT STAND**

Early placement of bone into a bony defect seems sound, but evidently there are other factors involved: (1) Not all clefts require bone grafting; (2) traumatic surgery in the area of young growing bone may affect subsequent growth; (3) scar or bone graft rigidity may retard growth. Yet a number of surgeons still favor primary bone grafting into the cleft followed by orthodontics to maintain arch position. The majority, however, seem to feel that, as this surgery does not invariably prevent crossbite and may retard maxillary growth, it is best postponed until after complete facial growth and permanent dentition!
IT is interesting to note that Francis Mason of London, in his 1877 book *Harelip and Cleft Palate*, wrote:

The great advantage that Langenbeck claimed for the separation of the periosteum was that the new palate is composed of bony substance. "The osseous formation," he remarks, "takes place about the third week after operation. It is completed at the end of the fourth week and afterwards attains considerable solidity." He tested its strength by trying to pass a needle through it and believed that ossification had really been effected. Doubts, however, have been thrown on this point, for it was supposed that the toughness was due merely to cicatricial tissue.

M. Marmy experimented with this operation in dogs’ palates and found that, although union was exceedingly tough and almost as hard as bone, no true osseous tissue was formed. M. Ollier clarified the issue:

If there may be doubt as to ossification, all must admit that it forms a very resisting surface which has the strength and takes the place of bone.

In 1909 in Cleveland, at a meeting of the American Society of Orthodontists, a presentation was made by Wayne Babcock on osteoplastic operations for the correction of deformities of the jaw. Robert Dunn then asked an interesting question:

Orthodontists are frequently required to correct cases of malocclusion where the operation for cleft palate has already been performed and there has been a failure in getting union in the anterior portion of the cleft. In the operation that follows there may be some opening of the cleft. Does Dr. Babcock consider that bridging the gap with a flap or periosteum would result in a restoration of bony union?
It was almost 60 years before attempts were made to answer this question.

SKOOG

In the shadow of picturesque twin cathedral spires, Tord Skoog of the University of Uppsala, Sweden, compact in stature, always demonstrated evidence of the quiet, controlled drive and strength that once made him a Swedish national 400-meter runner. It was his good fortune to produce lovely twin daughters, both of whom were 400-meter runners for their national track team.

Although still using rib bone grafts in alveolar clefts in 1965, Skoog noted at the Second Hamburg Cleft Palate Symposium in 1964:

One interesting observation may be mentioned from our series on maxillary bone grafting. In a case which had not been grafted, and in which collapse had occurred following soft tissue repair, a substantial bone bridge developed spontaneously between the premaxilla and the lateral maxillary segment during expansion. The explanation may be that in the first operation the periosteal membranes had united across the cleft. This may indicate that the function of the grafting procedure is mainly to provide a framework along which periosteal continuity between the maxillary segments is restored.

During the same symposium Professor Gerhardt Steinhardt of the University of Erlangen-Nürnberg responded to Skoog’s observation:

In the last month I visited the clinic of Professor Oberniedermayr in Munich. In conversation, Dr. Singer, his first assistant, told me of an interesting case of bone union similar to what Dr. Skoog told you about just before:

In a double cleft lip and palate operation the transplanted bone was lost by infection after 14 days. In any case bone consolidation occurred. My question: Is bone grafting a real transplantation or only a stimulation?

As chairman of the Symposium, Professor Schuchardt closed this discussion with:

As far as I know, Dr. Singer, first assistant to Prof. Oberniedermayr, uses routinely in cases of double sided clefts vomerine bone for the osteoplasty which he places only in one side. To do this he has to dissect the periosteum
from the bone. Parts of the periosteum might act as a stimulation for the bony union. . . .

Besides this we know that in a favourable osteoplastic milieu, every mesenchymal tissue, even organized haematoma, and scar tissue can lead to bony tissue.

Then in 1967 Skoog reported, in the *Scandinavian Journal of Plastic and Reconstructive Surgery*, the use of periosteum and Surgicel for bone formation in congenital clefts of the primary palate. This principle has become known as the “boneless bone graft.”

In the same year and not far from the Coliseum in Rome, with the front stage of the main auditorium of the Hilton as the prize ring and the Fourth International Congress as cheering spectators, an impromptu world’s heavyweight “cleft alveolar” title fight erupted. In one corner was Karl Schuchardt, a champion of bone grafters. In the other corner was Tord Skoog, defender of boneless grafters. Schuchardt, the puncher, got in a few heavy blows, while Skoog, the boxer, jabbed and danced for points. The match was stopped after the first round and declared a draw for lack of sufficient evidence.

Skoog continued his work and in 1969 stated:

This surgical procedure is based on three main premises:

1. The periosteum covering the maxillary segments possesses normal growth potential.
2. Denuded bone in this area will regenerate normal periosteum similar to other bones.
3. The re-established interaction between growth centers on the medial and lateral sides and the biomechanics of the soft tissue environment will determine the growth and development of the united maxilla.

Skoog’s operation involved subperiosteal exposure of the bone bordering the cleft and the establishment of periosteal continuity.
between the maxillary segments across the cleft, utilizing local flaps of the periosteal membranes.

The nasal closure is obtained with standard mucoperiosteal flaps elevated from the sides of the cleft, both superiorly based. The oral covering flap of periosteum is taken from the external surface of the maxilla, based superiorly and medially near the infraorbital foramen, and is transposed 90 degrees over the anterior alveolar portion for the two-layer closure.

To add to his ammunition, Skoog demonstrated experimentally, in rabbits, bone formation in a subperiosteal hematoma beneath the periosteum of the nasal bone. He elaborated on his plan to stimulate even more bone formation:

The average result utilizing periosteum alone for repair of the complete cleft is a fairly narrow and thin bridge of bone. . . . In order to secure more bone formation . . . Surgicel® (oxidized regenerated cellulose) was used as a matrix . . . as a scaffolding to keep the periosteum in the desired position and to maintain a hematoma in the area.

Since obtaining a watertight periosteal pocket is difficult, Skoog formed the periosteal pocket at the time of lip closure (3 months). The second stage was performed 3 to 15 months later with an incision through mucoperiosteum down to the newly formed bony bridge and dissection of a pocket into which Surgicel was packed. Careful closure completed the procedure. Skoog even advised combining periosteoplasty with implantation of Surgicel during primary closure of incomplete clefts of the lip but found local edge periosteum adequate for a pocket.

One reaction Skoog received from his periosteal flaps, besides the formation of bone spicules, came from Johanson. In reference to bone absorption in grafts, Johanson remarked:

Incidentally, Tord Skoog used this report of Joss to justify his implantation of synthetic material to replace bone. We thought that it would be interesting to open up the graft in one of our cases to see what had happened. . . . I did this in January of this year, about six years after the bone graft, and the area where the bone graft was looked exactly as if it was a nonclefted case. I hope that Dr. Hellquist communicates with Tord Skoog so that he gets this information, because I have not been very successful in this regard.
In his superb 1974 book, *Plastic Surgery: New Methods and Refinements*, colorfully illustrated and beautifully written, Skoog presented an extensive review and defense of his "boneless" bone grafting. He noted that Ollier, one of the pioneers of free skin grafts, in 1867 clearly demonstrated the osteogenic capacity of the periosteum. Yet two clinical observations started Skoog toward developing the technique of periosteoplasty. (1) A maxillectomy on a 4-month-old child with melanotic progonoma left the periosteum in place. Complete bone regeneration was confirmed by x-ray studies two years later, revealing normal maxilla except for missing teeth. (2) A complete bilateral cleft operated on in 1957 with soft tissue closure formed new bone spontaneously within one of the two clefts. This occurrence was interpreted by Skoog in 1966 as the result of periosteal membranes, unintentionally united across the cleft at the primary operation and subsequently forming solid bone.

Skoog acknowledged:

Criticism of this technique of maxillary reconstruction has reflected anxiety about operating on the juvenile maxilla. Fear of endangering future development has engendered this feeling.

He then hastened to point out:

In a study, using implant techniques, Björk (1966) confirmed that the anterior portion of the maxilla was never a growth site. There is thus little to suggest that maxillary development would be iatrogenically impaired when performing a periosteoplasty.

Swedish researchers were stimulated to study the possible effects of periosteoplasty on maxillary growth in animals. In 1972 E. Engdahl, using 300 rabbits aged 2 to 3 weeks, performed unilateral maxillary resection varying the position of the periosteal lining and the material used to fill the defect (blood clot, bone marrow aspiration). In 1974 Skoog interpreted the results:

This series of experiments shows that the maxillary periosteum possesses an osteogenic capacity capable of completely regenerating bone.

Also in 1972 R. Hellquist, using more than 100 growing rabbits and guinea pigs, studied the effect of removing the
periosteum from the facial bones. An example of an adult guinea pig demonstrated normal bone growth and cranial development after unilateral periosteal resection of the facial bones at 6 days of age. Another example of an adult rabbit revealed no impairment in growth despite extensive unilateral removal of periosteum at 10 days of age. There was one important notation, however:

In several animals in the rabbit series, damage to perforating maxillary vessels resulted in deviation of the snout towards the operated side.


- The periosteum covering the maxillary segments in cleft deformities possesses a remarkable growth potential, but this force remains inactive until the periosteum bordering the bony defect is surgically manipulated.
- When the periosteum is shifted across a cleft, its osteogenic capacity is harnessed to rebuild the bony defect. The cambium layer, separated from the bone and placed in contact with a hematoma, induces the characteristic tissue reactions of bone repair.
- Properly arranged, the periosteum will lay down more bone than conventional bone grafting procedures. In fact, the skeletal anatomy can be restored extensively, including the hypoplastic piriform border and the underdeveloped portion of the lateral segment. This segment is the best source of bone-forming periosteum, the thick membrane on the inner aspect being particularly potent. Also, extensive mobilization of the periosteum of the lateral maxillary segment can be carried out without interfering with bony sutures or other growth centers.
- Periosteoplasty is most effective at an early age and is preferably performed in conjunction with the primary lip repair. The operation has, however, proved to be quite effective up to the age of five and in a few cases up to eleven years of age.
- Following periosteoplasty the tendency for maxillary collapse is reduced by the rapid formation of new bone within the cleft.
- Periosteum induced new bone grows with the individual, unlike the static transplanted bone.
- In addition to growing with the individual, this bone responds to maxillary orthopedics. If maxillary collapse should occur in cases of major deficiency, up to 9 mm. extension of the bone bridge has been achieved by
expansion treatment. Bony substitution of the original defect will thus be completed.

- Bone formed by the local periosteum is of a dentoalveolar character.
- The tooth buds, compressed within the reduced volume of the lateral segment, will regularly migrate into a more normal position when new bone has formed, and in the cleft area they will erupt through this bone.
- Periosteoplasty is useful to correct the extensive bony deficiency associated with even a minimal cleft lip. The technique is recommended as an integral part of repair in clefts of all degrees.
- Surgicel® can be used advantageously as a scaffold to support the raised periosteum at the desired level, thereby regulating the volume and shape of the newly formed bone.
- Bone surfaces deprived of periosteum in the flap transfer will regenerate a new periosteal layer, which will be thickened and hyperactive at first, but will gradually acquire a normal appearance.
- The regenerated periosteum has good osteogenic qualities, which permit repeated periosteoplasties to be performed, resulting in additional bone formation.

In fact, bone formation is not consistent or predictable and thus may require repeated periosteal “flaps” to create enough bone to be functional.

In 1976 orthodontist Rune Hellquist and Tord Skoog gave a report of 66 complete unilateral clefts of the lip and palate, 36 with primary periosteoplasty and 30 without. They made several observations:

In all patients who had undergone periosteoplasty, new bone formed within the alveolar cleft. A good amount of new bone developed in about half the
number of cases. Bone formation increased after repeated periosteoplasty and new bone bridging the cleft was then a constant finding. . . . Infant periosteoplasty, involving transfer of local periosteum across the alveolar cleft, is effective in restoring framework and . . . does not retard or impair growth of the maxilla during a follow-up period of 5 years. . . . In the deciduous dentition, no differences were found in intercanine and intermolar dimensions between the periosteoplasty cases and the controls. . . . The new bone formed in the cleft area after periosteoplasty does not seem to withstand the contracting forces introduced by palate surgery.

Tord Skoog had promised to send me some x-ray films of his periosteoplasty and because of his untimely and tragic death did not; Bengt Pontén kindly forwarded the two accompanying cases. In 1976 effervescent, forthright George Joss of Norwich, England, once a rugby player at Aberdeen University and now just as vigorous in cleft surgery, wrote what he considers to be "The Place of Boneless Bone Grafting—a gimmicky title which I have now dropped in favour of Periosteoplasty." It all started on Joss's World Health Organization Fellowship tour of the cleft palate primary bone grafting centers of Sweden and Germany. Here is an outline of his 1966 to 1976 transition:

1966—W.H.O. Fellowship to study bone grafting in cleft palate in Sweden and Germany. "Best Buy" considered to be the simple Widmaier flaps seen in Dr. Schmid's Clinic, Stuttgart. Reading literature; found same flaps described by Andrew Campbell, F.R.C.S., Ed. (B.M.J., 1926).

1966—Commenced a study using Campbell-Widmaier flaps plus Skoog flap, with implantation of rib grafts or bone marrow injection in alternate cases as a comparative study. By accident (anesthetist stopped case before bone implanted), one case of bilateral cleft had flaps but no bone graft or marrow. 6 months later (1967), X-ray revealed bone had formed spontaneously; just as good.

Great excitement! Realized bone graft may be unnecessary; periosteal flaps appear to be sufficient.

1967—Clinical research carried out on large number of patients who had periosteal flap repair (Stellmach), but no bone graft. (Easily identified by their computer.) Kind permission of Professor Rehrmann.

Findings: Periosteal bone formation without bone graft confirmed in every case but one (breakdown due to infection). Spent whole of one night photographing X-ray evidence; (fear of Gestapo!).

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Comment: Perhaps Professor Rehrmann did me a good turn in declining permission to publish. Although initial results were very gratifying and unquestionably periosteal bone formation developed in every case, the longer term follow-up introduced disappointment. All cases of unilateral cleft incorporating Millard repair with initially excellent lip and nose formation. Gradually, with dentition, evidence of lateral segment crossbite and even some anterior crossbite developed. Formation of nostril deteriorated by age 3 to 5. Significant percentage developed fistula at junction of hard and soft palates—presumed due to difficult compatibility of Campbell flaps with Kilner-Wardill cleft palate repair.

It had been believed that the ease of bridging even the widest cleft with Campbell flaps would eliminate the need for post-operative orthodontic correction. 10 year study of method intended but plans revised.

1971—Post-operative orthodontic correction by static retention appliance (similar to Georgiade plate). This introduced a previously unintended variable into the study but succeeded in preventing anterior and lateral crossbite due to alveolar collapse.

1973—Visit to Professor Skoog in Uppsala. Despite being on Sabbatical leave (due to coronary thrombosis), Skoog kindly demonstrated his method on two children with complete unilateral clefts. Decided to abandon my own method, and therefore, 10 year study of Boneless Bone Grafting with Campbell and Skoog flaps, because incidence of palatal fistula too high to accept.

1976—I now use Skoog's periosteal flap technique alone, except that I do not personally think that re-operation each 3 months to raise a further periosteal flap is acceptable. My method now is to use a Millard lip repair in all cases, combined with Skoog alar rotation and his periosteal flap.

In 1977 Joss wrote from Norwich prior to leaving for a locum in Riyadh, Saudi Arabia. I still remain firmly committed to periosteoplasty and perform it on every case of complete cleft.

Other surgeons began using the Skoog primary periosteoplasty.
O'BRIEN

The ingenious and extroverted Bernard O'Brien of Melbourne, Australia, is one of the world's leaders in microvascular surgery and the transfer of "free flaps." He started at an early age to attain great heights, which won him the Melbourne University pole vaulting title from 1946 to 1950 and the honor of representing the state of Victoria in the national pole vaulting championships, and also the Australian Universities' championship. When he was not vaulting from a pole, he was tossing one as the University javelin throwing champion for several years.

O'Brien cited the observations of Joss, who, when touring the Scandinavian and West German units, noted absorption of bone grafts regardless of the method. He admitted similar experience with his own grafts and became interested in the boneless bone graft of Skoog, which had also been embraced by an Italian, Santoni-Rugiu, in 1966. O'Brien explained his approach:

A Millard cleft lip repair in the unilateral clefts was associated with a two-layer periosteal closure of the primary palate (Skoog) and one-layer closure of the hard palate. The secondary palate cleft was closed at the age of one year by incorporating the palatal island flap (Millard) to lengthen the nasal layer. Preoperative and postoperative photographs and models with serial x-ray studies have been carried out in all cases (12).

He confirmed Skoog's findings of spontaneous bone formation within six months and summarized his follow-up of five months to four years:

(1) That bone forms spontaneously in the primary cleft is evident within six months and increases with time;
(2) that satisfactory alignment of the alveolar arch is achieved, and
(3) that bone deposition following "Surgicel" implantation at the time of the secondary palate operation may lessen alar base asymmetry.
There has been no evidence to date of interference with maxillary growth.

In late 1976 he wrote me his most recent stand:

My experience in this procedure extends over a ten-year period. I have reserved it for wide clefts, both unilateral and bilateral. No orthodontic treatment has been carried out prior to surgery unless the premaxilla has been very projected.
The largest possible periosteal flap has been elevated. The dissection can often be carried out more efficiently with the surgeon standing on the opposite side of the patient. There needs to be careful preservation of the base of the flap.

There has been good radiological evidence of bone formation in every case and good bony union has been obtained. A longer term follow-up is necessary though the results have been promising. Some orthodontic treatment has been required at a later age, but there has been no case yet that has needed a secondary bone graft. I am continuing to use this method.

**RINTALA**

In 1974 A. Rintala, A. Soivio, R. Ranta, T. Oikari and J. Haataja of the Finnish Red Cross Hospital, Helsinki, reported 63 patients (54 with cleft of the primary and secondary palate and 9 with cleft of the primary palate only) on whom the maxillary periosteal flap technique of Skoog had been used. The surgery was performed at age 3 months and the last x-ray films were taken at 3 years. These workers noted:

The periosteal flap formed a manifest bone bridge in 54% and a diffuse bridge in 22%, whereas no bone formation was seen in 24%. Whether implantation of Surgicel was performed in the same stage or omitted did not seem to affect bone formation, any more than it did the original width of the alveolar cleft.

**OHMORI**

Seiichi Ohmori, the doyen of Japanese plastic surgery and an oriental Marco Polo in reverse, has ventured throughout the world in search of ideas to bring home to develop. Two of them were free flap transfer and Silastic implants in auricular reconstruction, and he is now involved in primary periosteoplasty. In 1977 at the Toronto Congress, with Yuiro Hata of the Tokyo Metropolitan Police Hospital, Ohmori reported on 380 Skoog-type primary periosteoplasties using Surgicel in the pocket. These were carried out at 3 to 6 months, and as the bone formation at the maxillary cleft was proceeding (65 percent showed some bone
formation), an improvement of the alveolar arch and nasal floor was seen in most instances. Orthodontic treatment was necessary for the more severe cases. One of their cases is presented here.

Interestingly they noted:

Recently, if the patient has a wide cleft, a free periosteal graft from the tibia has been used as it is difficult to obtain sufficient tissue from the maxilla.

OTHER OPINIONS

There has been, however, a varied reaction to boneless bone grafting and the question of bone formation between two opposing layers of mucoperiosteum.

Reichert

In 1970 H. Reichert, a primary bone grafting proponent, noted:

In many operated palate clefts, bone is found years later when at the time of closure, only periosteum attached to nasal and oral layers was sewn together in the midline. Skoog (1967) called this phenomenon "boneless bone grafting." However, the development of this bony layer takes time, during which deformation of the dental arch may occur, and the wider the cleft the more likely this is.

Georgiade

While visiting Duke University in July 1971, I observed Nicholas Georgiade executing a Campbell-type, two-layer mucoperiosteal flap closure of an alveolar cleft. He was asked:
Do you get bone?

His answer was quite straightforward:

We’ve heard the big boys, but we still do not get bone.

*A Danish study*

In 1974 Uwe Prydso, Peter C. A. Holm, Erik Dahl and Poul Fogh-Andersen reported bone formation in palate clefts after palatovomerine plasty. Since the 40’s Fogh-Andersen had closed the primary palate at 2 months of age with two mucoperiosteal flaps according to Veau. In 1970 Dahl showed that 91 percent of these patients developed crossbite, and later he convinced Fogh-Andersen to study the process by taking biopsies. Finally, the intelligent, droll Peter Holm, a rising new star in Danish plastic surgery, entered the study. Prydso also joined the group as histochemist to evaluate the microscopic specimens. Here is Holm’s synopsis of the project:

Here in Denmark we have the best controlled material on boneless bone grafting and we have seen the effect of this bone formation on the adult patients. This is important work because the research has been carried out on human beings. At 22 months of age, a bone biopsy including both halves of the hard palate and nasal septum was taken from nine children with complete unilateral cleft who had had previous surgery at the age of 2 months. The newly formed bone had fused with the nasal septum and the palatal shelf. No suture had developed. The bone contributed normally to vertical growth of the nasal and oral cavities.

To evaluate appositional growth activity on the buccal aspect of the maxilla, periosteal biopsies from the region of the second deciduous molar on both sides were taken from the same children, revealing reduced appositional growth activity on the cleft side. Alkaline phosphatase reaction was twice as slow on the cleft side as on the non-cleft side. Biopsies of all nine children showed the same result. Biopsies from a control group of unoperated children of 2 months of age with unilateral complete clefts showed *no* difference in enzyme reaction on either side.

The conclusion of this investigation was that surgical procedures should be postponed as long as possible; surgical procedures which result in bone formation across the cleft should be abandoned.

Peter Holm
In 1969 at Jackson Memorial Hospital, Miami, Florida, during primary closure of a unilateral cleft lip, a student of Skoog’s was available to create a “Skoog” maxillary periosteal flap which was thin and riddled with perforations, not unlike the finest Swedish lace. No bone formed in this cleft, and although one case is no test, it did occur to me at the time that such a flap probably does not have a generous blood supply and thus acts as a free graft rather than a pedicle one. In 1969 I designed a periosteal free graft experiment on rabbit skulls for M. H. Heycock, Maytag Fellow and now plastic surgery consultant in the shipping center of Hull, England, and medical student B. M. Barrett, Jr., now a plastic surgeon in Houston, Texas.

Nine rabbits 8 weeks old were used. The scalp was incised in the midline and an epicranial periosteal flap was elevated so that a quarter-inch-wide...
burr hole could be drilled in the skull. A free graft of periosteum taken from the opposite side of the skull was placed in the hole over the dura, osteal side up, and covered with Surgicel. Then the periosteal flap was replaced over the hole in the bone and the scalp closed to duplicate the principle of Skoog. The opposite side, with a skull bone hole devoid of any periosteum, was left as a control. The rabbits were sacrificed at various times from 10 days to 22 weeks. The microscopic findings were of interest. Although two control holes produced a thin layer of bone and four experimental holes with periosteal grafts produced no bone (as seen in the section of rabbit No. 2, sacrificed at 21 weeks), the experimental holes with periosteal grafts unquestionably produced more bone than the control holes. Five of the experimental free periosteal grafted holes produced bone (as seen in rabbit No. 3). The four that did not were complicated by infection, loss of the periosteal graft or early death of the rabbit.
From this experiment it was difficult to show that free periosteal grafts were responsible for new bone formation. When the new bone did form in the periosteal pocket between the graft and the epicranial periosteum, rather than in scar or on the dural side, it was thicker at the edge of the defect and thinner in the center, suggesting new bone was being laid down from the bone margins rather than the periosteum. Rabbit No. 6 demonstrates this.

The presence of Surgicel promoted giant cell formation with only a minimal amount of new bone.

In 1972 the Finnish team of V. Ritsilä, S. Alhopuro, and A. Rintala reported their study of free periosteal grafts. In this first publication on the subject in the literature, they acknowledged the effectiveness of periosteal grafts in forming bone.

In a subsequent article in 1972, in the *Scandinavian Journal of Plastic and Reconstructive Surgery*, Veijo Ritsilä, Sakari Alhopuro, Uno Gylling and Aarne Rintala of the Finnish Red Cross Hospital, Helsinki, after more than 80 Skoog periosteal flaps and their own successful bone formation following free periosteal grafts in animals, wrote:

> From our experience, at least in wide defects it can be very difficult to cut a flap with a wide enough base: the flap often becomes little more than a string whose contiguity with the maxilla is illusory.

The usual mucoperiosteal flaps are used to close the nasal side of the alveolar and anterior palatal cleft. A free graft of periosteum taken from the anterior tibia, 1 by 4 cm. in size, is used as a bridge. With the bone side inward, the periosteal graft is fixed with catgut to the maxilla on each side of the cleft, establishing a two-layer periosteal continuity between the maxillary segments, and the entire graft is covered with oral mucosa. The Finnish team followed these cases carefully with regular x-ray studies and reported:

> The bone forming capacity of free tibial periosteum where transplanted to the maxillary cleft is undoubted. After 2 weeks there is callus in the area of transplantation and after 6 weeks definite bone can be observed in the area.

Veijo A. Ritsilä started as an orthopedic surgeon and in fact is still the leader of the Research Laboratory at the Orthopaedic Hospital of the Invalid Foundation in Helsinki. He has recently visited bone research laboratories in New York, Los Angeles and
Toronto. In 1975 in Paris he noted, with Alhopuro, Ranta and Rintala, that
free periosteal grafts from the tibia have definitely stronger bone forming capacity than the local maxillary periosteal flaps.

In 1976 he answered my question as to how he got interested in free periosteal grafts by commenting on the difficulty of cutting healthy flaps of periosteum with a wide enough base. Then he added:

I have thought, too, that in maxillary cleft areas, there is often a growth disturbance per se, and it is unwise to use this "sick" maxillary periosteum from the area. The tibial periosteum has maybe a greater growth potentiality because it is planned to grow more rapidly than the maxillary periosteum. In this way, free tibial periosteal grafts could bring new healthy mesenchymal tissue possessing more growth and bone formation potentiality to the defect area of the maxillary cleft, which perhaps is condemned to the underdevelopment in the growth area.

At the Finnish Red Cross Hospital we have compared roentgenographically our material of 22 patients in the respect of bone formation with a series of 63 patients operated with the local maxillary periosteal flap techniques (Skoog) in our hospital. With maxillary periosteal flaps, a definite bone bridge was achieved in 54%, diffuse ossification in 22%, and no bone formation in 24% of the patients. The corresponding figures in the series of 25 free tibial periosteal grafts are 76%, 12%, and 12%. Our experience is that a free periosteal graft produces more bone in a shorter time and with less failures than the maxillary periosteal flap.

At the time of the occlusal X-ray controls, also alginate impressions of the alveolar bridge and palate were taken. The follow-up period has been on average 4 years. Using incidence of crossbite as a basis for comparison, results of this material with free periosteal transplants compared with our earlier material with and without local periosteal flaps. In respect to the dental occlusion, there was no marked difference, but definite growth of the alveolar complex in the antero-posterior direction could be seen. Growth stimulation in the lesser segment could also be detected. However, the observation period is still too short to assess conclusive results.

In two last years I have proposed and used free periosteal and also perichondrial grafts in clinical orthopaedics in the spinal fusion of scoliosis, in the treatment of congenital and post-traumatic long bone pseudoarthrosis and in reconstruction of articular cartilage destruction or defects. Also, my free periosteal transplantation method has now applied clinically to reconstruction of tracheomalacia and tracheal stricture in some European countries.
A series of x-ray films reveals the situation: (a) preoperative cleft, (b) two weeks after transplantation, and (c) one year after the free periosteal graft.

Bone formation can be seen, and a tooth is erupting through the newly formed bone.

Although realizing it is too early to evaluate this work, he made several pertinent points:

Periosteal grafts are easily available and cause the baby no trauma worth mentioning. . . . It is unnecessary to detach the maxillary peristemeum, which can be difficult and may cause disturbances to the normal periosteal bone growth. . . . A periosteal graft does not produce the immediate orthopaedic effect which can be achieved with a bone graft. But if a good alignment of the alveolar arches is achieved preoperatively, or even postoperatively by the pressure of the reconstructed lip, the transplanted perios­teum provides a rapid fixation of the arches. A periosteal graft, unlike the bone graft, does not undergo the resorptive stage before bone formation.

The advantages of periosteal free grafts over maxillary flaps cannot be denied. The only question that still bothers me is whether effective bone will be formed consistently.

Although periosteal pockets across the alveolar cleft have been created through the years, it is possible that more bone has been laid down in them than has been realized. The principle is an interesting one but seems to have some of the drawbacks that regular bone grafting suffers—trauma, dislodgment of peristemeum and scarring. The bone formed appears to be variable and un­dependable, often requiring several periosteal flaps for sufficient bone formation. Perhaps in time we will find that this new bone and the accompanying scar acts as a restraint to growth, or it may turn out to be just what the patient and the surgeon need.

Following a group of papers on primary periosteoplasties by flaps and free grafts came one of the highlights of the Toronto Congress on June 8, 1977.

**Scene:** Concert Hall, Royal York Hotel

**Debate:** Resolved, That Periosteoplasties Are an Excellent Method of Primary Maxillary Alveolus Repair.

**Affirmative:** I. T. Jackson, Scotland

**Negative:** E. S. Broadway, England
The argument for primary periosteoplasty was presented well, with fine cases showing good results. Both the Skoog flap and the pericranium free graft had been used. Jackson, in all honesty, admitted that his follow-up time was not long enough and, although early results were promising, harmful later effects might cancel the benefits.

The argument against was championed by the orthodontic representative of Joss's unit, E. S. Broadway. I had been warned ahead of time that for the sake of debate, this would be a trumped-up argument for the negative, when actually they were still proponents of the primary periosteoplasty. Broadway presented cases in which primary periosteoplasty had been used and which revealed crossbite, with the implication that the method had been, and should be, abandoned.

Then a vote was requested from the audience on how many would do primary periosteoplasties on the basis of the data presented and not on whether they had been doing the procedure previously. The show of hands was estimated at one-quarter yes and three-quarters no.

I wrote Eddie Broadway for the facts and this was his response:

The truth is that George Joss has been carrying out primary periosteoplasty for about 10 years. The results are very variable, some excellent and some rather indifferent. Bone certainly forms in some, but by no means in all. I do not know why, and I do not think anyone else does.

I do not agree that bone across the cleft prevents or modifies bone growth of the upper jaw. I cannot agree with the concept that the bone is like a strut preventing collapse or stopping lateral development. The bone, no matter how it is formed, is a living material and will react to pressure or stimulation.

The problem of growth disturbance is much more likely to be due to the lifting of large flaps of periosteum off the growing bone and it is the donor site which is the important one, not the recipient area which everyone seems to concentrate on.

**MICROVASCULAR ANASTOMOSIS OF PERIOSTEUM**

The problem with the Skoog periosteal flap seemed to be its poor vascularity and inconsistent formation of small amounts of bone.
The same seemed to be true of free periosteal grafts. Then senior resident John M. Finley of Indiana University, Robert D. Acland, director of microsurgery and Michael B. Wood, both of the University of Louisville School of Medicine, in 1978 presented their important work on dogs.

Rib periosteum was transplanted to the groins of 9 dogs. In half of the periosteal grafts, no microvascular anastomoses were done (free grafts); at 6 weeks after grafting they had become resorbed. The other periosteal grafts were revascularized by microvascular anastomoses of the intercostal vessels to local muscular vessels; at 6 weeks those with confirmed vascular patency had all formed substantial amounts of new bone.

Five cm, full-thickness defects were created in the tibias of 10 dogs. The control animals (without grafting) did not heal in two months. However, the experimental dogs, with vascularized periosteal grafts in the defects, regenerated their tibias with healthy new bone by 6 weeks—and were walking on them then.

They also noted that non-weight-bearing bony defects such as in the cranium and ulna did not form bone, indicating that mechanical stress may be a necessary adjunct to new bone formation. It was suggested to Finley and Acland that revascularization of periosteal grafts by microsurgical anastomosis could be a more dependable bone-forming maneuver in the cleft maxilla as the stress on the maxilla would aid in this process. Finley responded:

This work does demonstrate without question that periosteum can be quite osteogenic under the right circumstances. . . . With such vascularized grafts perhaps palatal defects could be bridged by soft tissues and new bone without the need to perform radical local mucoperiosteal or bone flaps. This could minimize resulting facial growth problems.

Acland was less optimistic:

Particularly with regard to the treatment of large palatal defects, I don’t think our experimental evidence would support a clinical trial of the method.
21. Standard Lip and Palate Closure

and Let the Segments Go Where They May

LONG, long before presurgical orthodontics and alveolar bone grafting, lips were closed in the early months and the palate at about 1 year. In 1787 Gerard, comparing the effect of lip closure upon the palatal cleft in a 9-year-old and a 30-year-old patient, advocated that closure of the lip be done "at a tender age" to bring forward apposition of the cleft palate edges. The early lip closure served for Gerard as an orthopedic device to narrow the palatal cleft. Subsequently many surgeons were enticed by the possible advantages of more sophisticated presurgical orthodontics and primary bone grafting into the cleft. Some who ventured into these new vogues were later to return to the standard approach. Others never left and were not afraid to admit it.

HARDING

Robert Harding, in his typically quiet, sincere, effective way, presented his findings:

In following our patients quite closely it has been our feeling that most of our patients would benefit little, if at all, from a primary bone graft.

He explained that he was not opposed to maxillary orthopedics and bone grafting but looked at these as a secondary or later procedure. Harding considered that a child with cleft palate, which in itself varies in each case, has the potential for "normal"
growth within the limits of his own genetic heritage and meta-
abolic environment. He expressed far more concern about avoid-
ing raw areas with scar contracture by conservative surgery and
waiting for subsequent gentle molding by united muscles, for, as
he said,

Growth is a gentle force and can be contained by an equal and opposing
force.

When the patient attained 10 pounds, Harding simply closed
the lip, unwilling “to dilute his attention” to other surgical
procedures. He reported good results with a modified quadrilat-
eral flap, a triangular flap or the rotation-advancement method,
but warned:

The first surgeon has the best chance!

Then, slightly out of character, he slipped the baby a nipped
bottle for the first feeding two hours after surgery!

At the time of palate surgery, Harding reported 50 percent of
patients with maxillary segment collapse, the other half showing
resistance due to end-to-end contact of segments, a large inferior
turbinate or the size and shape of the nasal septum and palatal
shelves. At present Harding closes the palate at 1 year in two
stages, the hard palate with a one-layer vomerine flap leaving the
alveolar cleft open and, four months later, simple approximation
of the soft palate, accepting a short palate primarily. In his series
are palate cases which were closed at 6 months and others in the
older age periods. Without adequate statistical data, he expressed
a general feeling that his “early” surgery did not cause any more
maxillary growth disturbance but did seem to improve speech
results. His final defense of the conservative stand included “both
the patient and the surgeon do better” and “our complications
are minimal with no mortalities in 2000 cases.”

MAZAHERI

Harding’s orthodontic teammate and co-captain, Mohammad
Mazaheri, backed his surgeon’s conservative stand and outlined
his figures following this sound treatment in unilateral cleft lip
and palate cases:

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1. Seventeen percent of all cleft samples were found to have some kind of transverse crossbite.

2. A large majority of the crossbites discovered involved only the anterior region.

3. The incidences of crossbite, either anterior, posterior or both, in unilateral and bilateral cleft lip and palate are:
   - *unilateral*: deciduous 47.5 percent; mixed 60 percent; permanent 17.2 percent.
   - *bilateral*: deciduous 20 percent; mixed 40.9 percent; permanent 26.7 percent.

Mazaheri concluded:

Treatment of these cases is no real orthodontic problem to us.

In 1972 Harding and Mazaheri repeated their conservative stand in reference specifically to 80 bilateral clefts, stating:

We decided to repair bilateral clefts of the lip and palate by as simple a procedure as possible, and to leave the alveolar clefts open so that the maxillary segments would be relatively free to mold and adapt. . . .

Repair of the lip with good restoration of the functional muscle matrix reduced the subsequent width of the cleft in the maxillary segments—as we had expected. . . . For example, a Simonart's band is often all that is needed to contain the maxillary segments. . . . The difference in the maxillary widths between the bilateral and the unilateral cleft lip and palate groups, although great at birth, became less significant after repair of the lip. . . .

There was a constant change in the segmental relationship of the premaxilla and the lateral segments during various stages of the arch development. In most patients in whom an overlap of the premaxilla over the lateral segments was present both before and after lip surgery, the segmental relationships began to change prior to 3 years of age and terminated with an end-to-end relationship after eruption of the deciduous dentition. Evidently spatial relations will improve with dento-alveolar adaptation, provided the segments are not locked in by a surgical design or by fibrous tissue, and provided the tongue is normal. . . . Underdevelopment of the mid-face with retrusion of the maxilla is, we think, the result of the individual's genetic heritage or of a false maxillary ankylosis secondary to surgery. Considerable progress has been made in cleft palate surgery in providing anatomical restoration which will restore function. It appears that we should revise our emphasis in favor of a better balance between effects on growth and early function, because the two will ultimately be interdependent.
In 1976 Mazaheri made a pertinent observation:

In patients we have followed longitudinally over the past 14 years, we have found that the No. 1 major variable in acceptable orofacial growth pattern is the surgeon. Of course, besides the surgeon, the type of surgery also has a great effect on this pattern of growth. Yet the type of surgery does not mean much if the surgeon does not do his job well.

**KROGMAN**

Wilton M. Krogman, anthropologist and director of research at H. K. Cooper Institute, Lancaster, Pennsylvania, recalled:

My concern with bones and growth stems from early childhood. At the age of nine while playing “buried treasure” with my twin brother, I struck bone in one of our random holes in a vacant lot. Further digging uncovered a skull which turned out to be that of a horse, followed by its entire skeleton more or less as articulated in life, lying on its side. . . . Time passed and in my Freshman-Sophomore high school years, I grew 8 inches at a greatly accelerated rate to 6 foot, 4½ inches. Thus a fast grower grew into a growth student.

I am, I think, the only active craniofacial growth researcher who spans the total progress in the field: craniometry (skull); cephalometry (head); roentgenographic cephalometry (x-ray head film). This trilogy of research methodologies is basic to the knowledge and interpretation of craniofacial and cephalofacial growth and development, both normal (non-cleft) and abnormal (cleft).

The increase in size and change in proportions, the maturational age changes, the sex differences, and the racial differences of the human skeleton have been combined by me into a sub-specialty, “Forensic Anthropology.” My *The Human Skeleton in Forensic Medicine*, 1962, is on the shelves of every law enforcement agency in the world. I am known as “the bone detective.” In the 1930’s, I was consultant to the Scientific Crime Detection Lab of the Cleveland Police Department, and still have my Police Card, signed by Eliot Ness (of TV “Untouchables” fame), who was Director of Public Safety. As a lab-man, I was never on the “firing-line.”

In 1975 Wilton Krogman, with Mazaheri, Harding, Ishiguro, Bariana, Meier, Canter and Ross stated:

It has been our feeling, here at Lancaster, that conservative surgery (properly timed, and offering a minimum of mucoperiosteal involvement) should not result in deviant and/or dysplastic maxillo-facial growth.
After 24 staggering pages filled with numerical tables and charts on growth measurements, they concluded simply:

On the basis of our two serial samples, CP and unilateral CL(P), we have observed that there is a general post-operative catch-up growth in both cleft types, more so in CP. It is our conclusion that conservative surgery has facilitated rather than inhibited or deviated growth in both the maxillofacial skeletal complex and the soft tissues of the labiofacial complex. In the data presented in this study, our hypothesis has been sustained.

If we swing from the conservative unit in Lancaster, Pennsylvania, to one in Sussex, England, the report is similar.

GLASS

Orthodontist Denis Glass reported in 1970 with C. R. McLaughlin as the surgeon:

At the East Grinstead Centre, no primary bone grafts are carried out as the cleft lip and palate team feel that the benefits, if any, are out of all proportion to the severity of the surgical procedure involved.

So at East Grinstead, the "merry ol'" standard approaches are used, with conservative vomerine resection for setback of the premaxilla in severe protrusion and lip closure at 3 months, and the palate closure at 18 months. The only treatment then is speech therapy until, at 4 years, when the anterior arch collapse and premaxillary protrusion receives dental orthopedic treatment to realign the segments of the maxilla in three to four months. This rapid expansion is accomplished with a CC spring appliance of two acrylic segments anchored to the lateral teeth with Adam crib and cap splints. It is designed for anterior, and not the posterior, expansion by a heavy stainless steel wire bent into the form of a double C. No bone grafting is used.

PRUZANSKY DEFENDS THE STANDARD APPROACH

Partially discounting the Graber, Slaughter, Brodie and Subtelny scare of years before, Sam Pruzansky balked at delaying palate
surgery pending completion of a major portion of maxillary growth. He stated:

It has become increasingly clear that the damage to maxillary growth lamented a decade ago was largely the byproduct of surgical practices no longer in vogue in the larger centers. The present generation of treated patients does not present the maxillary deformity that was untreatable by conventional orthodontic means.

He favored early lip closure with maxillary molding and standard, atraumatic palate closure with orthodontia available to correct any discrepancies in the adult dentition. He later elaborated at the 1969 Second International Symposium on Early Treatment of Cleft Lip and Palate, held in his hometown of Chicago. Having controlled his emotions through the afternoon of the second day, he finally rose, mentioned that the Proceedings of the First Symposium in Zurich had recorded a “Tower of Babel” and questioned whether this second symposium was not a repetition of the first! He then dropped a Pruzansky “cocktail”:

One fact is inescapable. That is, whether you use maxillary orthopedics and/or bone grafting, or whether you do not, some cases succeed and some fail. . . . Why? Never mind the percentages. Everyone knows that you do not achieve 100% success. What are the mechanisms for success and failure? Is it in the kind of surgery? Is it in the age at which you operate? Where is the difference?

Pruzansky concluded:

Let me summarize by stating that a survey of our cases indicated that, in the present practice of plastic surgery, the following variables inherent within the patient dictate whether the arch will collapse or not:

1. Size and shape of the alveolar processes adjacent to the cleft.
2. Size of the palatal processes.
4. Size and slant of the nasal septum.
5. Size and shape of the inferior turbinate on the side of the cleft.

Howard Aduss, orthodontist of Chicago, once played running guard in Big Ten football at Purdue University weighing only 175 pounds. Later he was trained by Sam Pruzansky and again proved his toughness by continuing to work closely with him.
while maintaining his own identity. In 1964, and again in 1967 and 1968, he co-authored papers on the cleft palate with Pruzansky and twice was senior author. At the Cleft Palate Symposium at Duke University in 1973 Aduss pointed out:

**Initial State**

Among unoperated infants with complete unilateral cleft lip and palate, excluding those with Simonart’s bands, there is considerable variation in presurgical morphology and the spatial interrelation of the cleft segments. Longitudinal studies, utilizing dental casts and cephalometric radiographs, have demonstrated that these differences often predict the effect of lip repair on the shape or form of the arch as follows:

1. The size and shape of the alveolar process adjoining the cleft is determined by the number of developing teeth at the margins of the defect. The presence of well-formed or even bulbous alveolar borders acts as a buttress to prevent “collapse” of the segments.

2. The size and shape of the inferior turbinate on the side of the cleft also determines the amount of medial movement that may occur. Where the turbinate on the cleft side fills the nasal chamber, contact between the deviated septum and turbinate may also prevent approximation of the segments.

3. The size, inclination, and degree of deviation of the septum, coupled with its relationship to the turbinate, may limit medial movement.

4. The size and spatial relation of the palatal shelves to each other have been shown by stereophotogrammetry to be highly variable. When the shelves are displaced “horizontally” toward each other, the tendency toward medial movement will be more inhibited than if the shelves are at a more acute angle.

**Subsequent State**

Repair of the lip allows the previously defined morphologic variables to interact as determinants of arch form.

A review of ninety infants at the University of Illinois has shown that after lip repair, three types of arch form were discernible: (1) symmetrical (. . . 35.5%), with approximation of the segments and a butt-joint at the alveolar border; (2) overlap, or “apparently collapsed” arch form (. . . 43.3%); and (3) symmetrical arch form, but without contact at the alveolar border (. . . 21.1%).

Aduss noted the similarity of the crossbite reported at the University of Illinois and that reported by Bergland in Oslo.
Neither had used presurgical orthopedics or bone grafting but had relied upon standard closure of the lip and palate. He also noted that there was less crossbite (less collapse) in these groups than in those using presurgical orthopedics and primary bone grafting.
At one time surgeons were obsessed with closing the hole of the cleft without great concern for functional velopharyngeal closure. The soft palate was considered a flap valve working like a trapdoor. In the latter half of the nineteenth century there was a Teutonic rise to power in medicine, spearheaded by Rudolf Virchow, and on the crest of this wave was the remarkably perceptive Philip Gustav Passavant of Senckenberg Hospital, Frankfurt, Germany. He wrote 23 scientific papers on such subjects as typhus, psoriasis, anal strictures, burns, tracheotomy, epispadias and cleft palate. In fact, in 1863 he published a monograph on “closure of the pharynx in speech,” which postulated a theory he expounded more fully in 1869.

In his 1869 classic dissertation Passavant described the velum as a muscular structure opposed by another pharyngeal muscular structure which was to become known as “Passavant’s pad.” He noted the “forward swelling at the level of the base of the uvula,” which he deduced formed a pharyngeal ridge that was “an essential condition of normal pronunciation.” After dissecting both frozen and alcohol-hardened specimens to trace the origins of the superior constrictor muscle, he found the fibers running in the pharyngeal wall at the level of his ridge and spanning hamulus to hamulus.

Passavant described what he considered normal physiological action of the palate and pharynx:

The velum is raised, but not as far back as the back wall of the pharynx, which stays fairly still: the back wall of the pharynx approaches the velum,
at the same time coming forward in a swelling at that height of the pharynx at which the approach of the side walls of the pharynx to each other also takes place. . . . This (bulging of the superior constrictor), accompanied by the raising and pushing back of the velum, causes the closing of the palate-flap which is essential for intelligible speech. This sentence is the most essential content of the whole of my earlier work. . . . There are then, in my opinion, two ways in which the palate closes: the first is necessary for speech and is caused by the activity of the levatores palati and the upper pharynx constrictor, or rather perhaps, the part of this muscle known as pterygo-pharyngeus, arising from the hamulus: the second is that occurring in swallowing, choking, vomiting, etc., here, the closing is further strengthened by the contraction of the pharyngopalatini.

As noted by Calnan, Passavant's theory of nasopharyngeal closure was accepted throughout the world without question and with only an occasional minor modification by most of the early doyens of palate surgery.

Claude Bernard's rather cynical 1865 remark, What we know may interfere with our learning of what we do not know, suggests the difficulty of exploding myths. It often takes an elephant gun to kill a "traditional" flea, but any pages devoted to this controversial pad have important information on the anatomy and physiology of the velopharyngeal mechanism.

Von Luschka, who was compiling his treatise on anatomy, at first opposed Passavant's theory that the superior constrictor caused approximation of the two halves of the uvula in a cleft palate when the patient said "ah." He later agreed that the superior constrictor muscle was partly responsible.

In 1935 and 1936 Denis Browne of London argued that the soft palate was a curtain shielding a contractile muscle ring of two overlapping slings, the levator palatini and the superior constrictor. He considered this ring similar to the anal sphincter and regarded the ridge on the posterior pharyngeal wall as being due to the palatopharyngeus muscle. In 1941 Michael Oldfield of Leeds, accepting the idea of levator and superior constrictor slings, added lateral slings of the salpingopharyngeus and pharyngopalatine muscles. George Dorrance of Philadelphia had an opportunity in 1932 to study two palates in action from above after complete destruction of the nose. In one, Passavant's cush-
ion was impressive; in the other, only rudimentary. He concluded that Passavant’s theory was correct and acknowledged that the ridge was formed by the superior constrictor muscle. Wardill of Newcastle accepted Passavant’s theory in 1928, suggesting that his cushion acted as a

valve seating for the upper surface of the soft palate.

In 1942 L. Stein stated that in speech, nasopharyngeal occlusion was due to elevation of the soft palate toward the transverse fold known as Passavant’s cushion, which is probably formed by the raising and folding of the pharynx wall.

He suggested that enunciation of vowels, energetically carried out during speech training, is a stimulus to greater activity of the velum and pharyngeal wall and, further, develops the muscular substratum of Passavant’s “cushion,” ensuring better closure of the nasopharyngeal cavity. In 1954 Hagerty and Hoffmeister used the distance between the soft palate and Passavant’s ridge as an index to speech after cleft palate closure. Barrett Brown gave his usual sound analysis in 1955 but included the myth, stating:

In the repair of cleft palate one goal should be to obtain the best possible function of the soft palate. This will require pliable tissue, sufficiently long to meet the posterior wall of the pharynx (Passavant’s pad) in the sphincter-like action of this region that closes the opening between the nose and throat.

**BATTLE OF THE BULGE**

James Calnan, professor at Post-Graduate Hospital, London, was the fair-haired favorite of Nuffield Professor Kilner during his later years. While at Oxford under Kilner, Calnan beheaded a tradition in a learned and comprehensive treatise on “The Error of Gustav Passavant” [and his pad], which was presented at Coronado, California, in 1953 and awarded second prize by the Foundation of the American Society of Plastic and Reconstructive Surgeons. As one of his most effective thrusts against the importance of Passavant’s pad, Calnan used the renowned Victor Veau, noting that in 1943, after study with radiographic methods, Veau had said:
What does Passavant’s ridge do, that mysterious formation which has already brought a century’s immortality to a Frankfort surgeon? Naturally we have had some experience of it. We have operated on 1,747 cases of cleft palate. First of all, Passavant’s fold exists hardly at all in one-fifth of the cases. It is used perhaps in deglutition. It has nothing to do with speech. A fold which projects for 1 cm. cannot in speech close an orifice 3 to 5 cm. in diameter. But the main question for us is to know if such a fold could be of useful help in assuring occlusion in those cases where we have reconstructed an insufficient palate. Behold that which experience has taught us: more often this fold is sited below the point where the velum seeks to meet the roof of the cavum—and that is understandable; the fold is formed by the functional hypertrophy of the upper fibres of the superior constrictor muscle of the pharynx, and as you have seen this constrictor stops at the level of the atlas.

He did allow that

There are some fortunate cases, which are rare, where the fold helps occlusion . . . but speech is not of good quality.

Browne’s modification of the Passavant theory compared the velopharyngeal sphincter to the sphincter ani. Calnan again used Veau to counter this stand:

Veau goes further and suggests that if the speech mechanism is comparable to the sphincter ani then man would long ago have found some other way in which to express himself.

Then, too, Veau’s speech analyst, Madame Borel-Maisonny, noted in 1950 that the posterior pharyngeal wall was always immobile in normal speech; movement, as indicated by a transverse fold, was taken as a sign of an incompetent nasopharyngeal sphincter.

Calnan confirmed Veau’s opinion but from his observations reduced the dimensions of the velopharyngeal orifice to a width nearer 2.0 to 2.5 cm., and the anteroposterior diameter to 1.0 to 1.5 cm. His measurement of the projection of Passavant’s ridge, moreover, was usually less than 1 cm. With lateral x-ray films of the palate and pharynx of various cases and key overlay sketches, he maintained his objections to Passavant’s theory and presented his final argument in five parts.
1. Inconsistent. Calnan noted that Passavant observed his ridge in only one of 50 normal subjects while using a postnasal mirror, and he hazarded the guess that Passavant was recording a gagging reflex rather than normal speech. Other inconsistencies presented pointed out the occurrence of Passavant’s ridge in less than 25 percent of unoperated cleft palates, but in all those cases it would rise, evidently if being required for speech. It appeared in the 1-month-old infant and the adolescent but was more common in the adult, and even varied greatly in the same individual over a period of time. When viewed from above after removal of the maxilla for carcinoma in four patients, there was no evidence of forward motion of the posterior pharyngeal wall during speech, but a pronounced ridge was observed at low level on gagging and swallowing.

2. Uneconomical. It would be a waste of effort and energy to ruck the posterior pharyngeal wall forward if a normal velum can reach and occlude the nasopharyngeal isthmus. Lateral closure or narrowing of this isthmus by salpingopharyngeus and palatopharyngeus muscle contractions is more efficient since the elevated velum is unable to occlude the lateral pharyngeal recesses.

3. Ridge too low. Passavant’s muscle bulge occurs on the posterior pharyngeal wall at the level of the arch of the atlas, but the height to which the normal soft palate lifts back during speech is about 1 to 2 cm. above the level of the atlas. As there are no superior constrictor muscle fibers above the arch of the atlas, the ridge rises at too low a level to play an active part in speech. Calnan condemned several surgical procedures with:

This is further confirmed by the consistent failure to obtain normal speech of all forms of pharyngoplasty which try to imitate Passavant’s ridge.

4. Contraction too slow. The relatively slow contraction and relaxation of the ridge, the stage of contraction lasting invariably for more than 1 to 2 seconds, contrasts sharply with the rapid movements of the velum, which are in the order of 0.1 to 0.01 second. In 1936 Wardill declared that the ridge remained erect throughout speech and did not relax until the velum returned to its position of rest. Calnan did not agree and noted no radiographic evidence of this assertion.
5. *Its fatigability.* Passavant’s pad becomes fatigued. In some adult patients with cleft palate, a well-marked ridge may be seen on the posterior pharyngeal wall on phonation of “ah.” If this sound is repeated at one-second intervals, the ridge becomes less marked and eventually unrecognizable after a few minutes. In sharp contrast is the effortlessness of normal rapid speech, which can be uttered at a rate of more than 60 words per minute for several hours.

Calnan’s concluding statement in 1954 was:

That Passavant’s ridge can and does occur in association with cleft palate is recognised; that it is a factor in normal speech is denied.

In 1957 Calnan’s continued interest in the truth about Passavant’s ridge stimulated him to collect further information. In 1956 Ardran and Kemp had studied a series of bulbar poliomyelitis patients using cineradiography. In one case, when the constrictor muscles of the pharynx were paralyzed, a Passavant’s ridge appeared on swallowing. In no case was a Passavant’s ridge seen when the posterior pillars of the fauces were paralyzed. The implication was that the palatopharyngeus muscle, not the superior constrictor, produces the ridge.

These findings, along with other data, caused Calnan to admit:

The ridge has been found to be of muscular origin but the muscle responsible for it has not yet been settled.

Calnan’s final conclusions in 1957 were consistent with his previous stand, but his emphasis had shifted:

In only four cases (of 158 cleft palate patients) did Passavant’s ridge make contact with the levator eminence of the elevated soft palate, and so play a part in . . . speech. In every patient the quality of rapid conversational speech was spoiled by obvious nasal escape. The adenoid pad is more important than Passavant’s ridge, for it is usually sited well above the latter. Adenoidectomy may cause nasal escape in speech irrespective of any damage done to the posterior pharyngeal wall.

He continued:

“Passavant’s ridge” should be mentioned only in small print as a footnote, in works dealing with speech, for its interest as the basis of another medical myth.

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In 1968 Carpenter and Morris offered additional evidence that in some individuals the pad’s activity appeared to be compensatory in nature, in terms of the reduction of the velopharyngeal opening and in terms of the appropriate and consistent manner in which this reduction takes place.

In 1969 Raymond Massengill, Thomas Walker and Kenneth Pickrell of Duke University reported that out of cinefluorographic films of 190 postoperative cleft palates, 18 demonstrated a Passavant’s pad. Although the presence of the pad did aid in velopharyngeal closure, there appeared to be no relationship between the presence of the ridge and the size of the velopharyngeal gap.

It is probably true that in the normal speech mechanism Passavant’s ridge is too low, too slow, inconsistent, inefficient and unnecessary, but in cleft palates, where the velopharyngeal sphincter needs all the aid it can muster, the heroic compensatory action of the superior constrictor muscle and/or palatopharyngeus muscle rucking a ridge may offer some help to a few, and any help is appreciated.

THE OMNISCIENT PASSAVANT

Passavant is best known for his pad, but his contributions outrange this ridge. In his critical evaluation of the results of the von Langenbeck operation, Passavant observed nasal intonation in speech following successful closure of the cleft palate. He ascribed this deficiency to the inability of the velum to reach the pharyngeal wall and, as early as 1862, began to develop procedures to facilitate closure of the velopharyngeal opening. During his surgical career his ingenuity led him to attempt almost every principle used today to reduce the velopharyngeal aperture. He achieved posterior extension of the palate by suturing the posterior pillars of the fauces together. He created a velopharyngeal synechia. He pushed the palate back. He brought the pharynx forward by folding a pharyngeal flap on itself. He fitted a collar-button obturator into a transverse velar incision to increase posterior projection of the velum. He did indeed spur the evolution of cleft palate surgery with the goal of not merely closing the cleft hole but correcting velopharyngeal incompetence.
III. Lengthening the Palate
23. **Lengthening of the Cleft Edges of the Uvula and Soft Palate**

**ONCE** the sophistication of cleft palate surgery had advanced beyond merely closing the cleft hole, attention turned toward closure of the velopharyngeal aperture. Ingenious efforts were directed to surgical procedures which in various ways caused lengthening of some portion of the palate toward the posterior pharynx. These procedures of V-Y, transverse incisions closed vertically, angled releases and Z-plasties seemed to parallel in part some of the techniques used by lip surgeons to lengthen the short edges of the cleft labial elements. The first such effort is accredited to André Myrrhen in 1706. It is reported that he lengthened a soft palate by a method not described to compensate for a completely destroyed uvula and caused no damage to the patient's speech.

**LENGTHENING THE UVULA**

In 1879 William S. Forbes of Philadelphia, while closing a cleft of the uvula, lengthened the velum by a curved incision which was a combination of V-Y and transverse incision closed vertically, similar to that used by Nélaton in incomplete lip clefts. This procedure undoubtedly created the longest uvulae in existence, whatever good that did!
The German E. Kuster attempted in 1882 to lengthen the velum with slanted lateral incisions in a V-Y type of principle similar to that used by Malgaigne in cleft lip. The result was a long, fascinating, trilobate uvula without improvement in function. Reverdin carried out a similar procedure in 1898.

In 1911 Vilray Blair of St. Louis used angled releasing incisions to form triangular flaps of the velum, not unlike his later cleft lip flap, to achieve palate length. By advancing palatal mucoperiosteum and cheek mucosa medially, he was able to get lengthening of the palate without too great side-to-side tightness. As he said:

The cleft borders of the velum are [incised] . . . on either side through the whole thickness of the soft palate and the flaps behind these incisions are rotated backward. In this way, the incisions . . . are opened and the raw surfaces thus exposed are sutured to each other at the median line. . . . This operation gives a longer velum than is obtained by the simple Langenbeck operation and therefore a better functional result is obtained. It will not permanently cripple the action of the superior constrictor muscle of the pharynx.

The most radical of the uvula-lengthening procedures was described in 1877 by Francis Mason of St. Thomas’s Hospital and Kings College Hospital, London. As he still agreed with Passavant and Gustav Simon that nasal twang in speech was due to
shortening of the palate, he was stimulated to describe and discuss an operation he had designed in 1869. With a sharp, pointed knife he divided the palate completely from the hamular process (A to B) bilaterally, noting that the parts united in a V-shaped angle. He explained his rationale:

The palate becomes converted into a huge uvula, so to speak . . . so that if it does not actually touch the back of the pharynx it approaches it so nearly as to divert the current of air to a considerable extent from the nose into the mouth, and thus greatly obviate the disagreeable guttural voice.

**Z-PLASTY LENGTHENING OF THE SOFT PALATE**

In 1950 T. P. Kilner of Oxford suggested obtaining the greatest possible length in the velum by making small incisions at right angles to the pared margins of the cleft or undertaking a Z-plasty of the nasal mucous membrane and, if need be, the palatal mucous membrane.

Randell Champion of Wythenshawe Hospital, Manchester, England wrote in the *British Journal of Plastic Surgery* in 1957:

The nasal membrane may be lengthened by undertaking a Z-plasty of the nasal mucous membrane. This small plastic manoeuvre is of utmost importance in the primary repair of a cleft palate and may make the difference between normal and imperfect speech. The Z-plasty also tends to reduce the palato-pharyngeal opening. In a small percentage of primary repairs it is not possible to perform the Z-plasty, particularly in clefts involving most of the hard palate. . . . In secondary repair of palate the creation of a large Z-plasty or two smaller Z-plasties may materially influence the final result.

As Lyndon Peer with Walker and Meijer of New Jersey wrote of the bone flap method in 1964 in *Plastic and Reconstructive Surgery*:

The procedure, however, does not provide for additional lengthening, and if one starts with a short palate, one ends up with a palate of the same length. If the shortening is marked, we lengthen the soft palate with a Z-plasty. . . .
The incisions for this Z-plasty include muscle and both mucous membrane surfaces.

**SCHUCHARDT**

At his Second Hamburg Cleft Palate Symposium in 1964, Karl Schuchardt spoke for improving "old methods." He philosophized before he promoted his own modification:

Besides this I think results do not only depend on methods but also on the way we use them. And I must say that with the old Langenbeck-Ernst-Veau procedure, which is described in the book of Axhausen and which I improved by the lengthening of the velum with a Z-plasty of the mucous membranes of the oral as well as the nasal side, we got such good anatomical shapes and functional results that I see no reason to change our procedure at all.
He spoke from an experience of nearly 1,000 cases.

In 1961 Edgerton facilitated palatal lengthening with sharp dissection of the neurovascular bundles. This resulted in a shortness in the nasal mucosal lining. He advocated the Z-plasty principle as his preference for lengthening this nasal mucosa.

A PALATE Z ROBS POOR
PETER IN PRINCIPLE

My concern about Z-plasties of the soft palate or nasal lining is basic. The mere presence of a cleft of the palate indicates missing tissue, which may vary in amount, and closure of the cleft necessitates pulling the sides toward the midline with relative tightening in the transverse dimension. This result will be more exaggerated with short, diminutive palates with wide clefts. Too much side-to-side tightness will, of course, counteract the effectiveness of the pushback by pulling against the levator action. The only excuse for using a Z is the longitudinal lengthening of the palate by bilateral transposition of flaps (the sum of the squares of the two sides of a right triangle is equal to the square of the hypotenuse) so that the palate would indeed be extended longitudinally. As in all Z-plasties, however, such lengthening is at the expense of transverse shortening, and if this dimension is already in trouble, as is usually the case, the problem is compounded with an overall loss—instead of a gain!
24. Palate Extension by Union of the Posterior Pillars

GUSTAV Passavant of Frankfurt, the father of operations designed to reduce the velopharyngeal aperture, in 1865 described a procedure which united the palatopharyngeal muscles in the posterior pillars of the tonsils for 2 cm. in the midline to effect the extension of the posterior velum back toward the pharyngeal wall. The upper portion of the mesial border of each posterior pillar was denuded and united by suture after lateral longitudinal incisions had been made in the anterior pillars. Speech was only slightly improved as nasal intonation persisted, as did Passavant in his search for velopharyngeal competence.

PILLARS CUT AS FLAPS

In 1871 William Whitehead of New York attempted to lengthen the palate by adding to it two lateral flaps dissected from the posterior pillars and the lateral walls of the pharynx. Probably with beads of perspiration on his brow, he explained:

I endeavored by a difficult and laborious dissection of the palatopharyngeus muscles, to form flaps with which to lengthen the velum palati. Having seized, with a pair of forceps, the palatopharyngeus on the right side very low down, I divided this muscle and a part of the mucous membrane of the prevertebral region, and dissected upward with a pair of curved scissors a flap more than sufficient to form, with a corresponding one on the opposite side, a long and dependent curtain to the new velum.

In 1897 Senn reported using flaps from the tonsillar region to reconstruct the velum in a case in which the soft palate was
absent. In 1909 Brandt mentioned using flaps from the region of the tonsils to close defects in the palate in children. In 1922 J. E. Thompson used oblique side cuts C-D and C'-D' through palatoglossal and palatopharyngeal muscles to allow medial approximation of the remaining velum. He reported:

The reconstructed palate was firm and strong, although somewhat short and stubby.

In 1910 Hyppolite Morestin of Paris, the octoroon from Martinique with a volatility of kitten-to-tiger temperament, lengthened the velum in a girl with defective speech after successful closure of her palate cleft. He accomplished this feat by suturing the posterior pillars of the fauces in the midline after incising each side on the slant from "without and upward to within and inward." He reported a satisfactory result.

In 1923 Makuen of Philadelphia incised through two-thirds of the palatopharyngeus muscle on each side, approximated their medial edges and used silver wire over lead plates to hold the closure against tension.

**RADICAL LATERAL FLAPS**

In 1925 flamboyant Eastman Sheehan of New York admitted to considerable loss of tissue in cleft palate failures following surgery. He argued that the palate muscles had blended with neighboring tissues and set out to find a way to use them. In a total cleft he designed bilateral flaps based anterolaterally, taking tissue from the pillars of the fauces, the tonsils and part of the lateral wall of the pharynx. He noted:
The upper point of the incision is well above the superior horizontal line of the faucial tonsil. The incision is carried well toward the cheek, then directly downward across the tonsil to include its upper two thirds, then backward over the posterior pillar, to include about a quarter of an inch of the pharyngeal membrane, then up to a level with the original point of incision. . . . The muscles, membrane and tonsillar tissue within these borders is then deeply separated, by the use of a long semicircular scissors with blunt ends.

The two flaps were united in the midline, and the raw area in the faucial regions was lined with Thiersch epithelial inlay grafts shaved off the inner surface of the thigh. A dental plate with two bars carrying molded stents was used to maintain the grafts. The residual anterior hole in the hard palate was later filled with an obturator.

It is interesting that this procedure is a reverse of the Gillies-Fry operation using skin grafts with a stent and ending up with an obturator in the hard palate hole. Sheehan had spent time at Sidcup and no doubt was influenced by Gillies' work and teaching. He and Gillies became "friends," and this is what Gillies once told me over a cup of tea:

When the Nuffield Professorship in Plastic Surgery at Oxford University was under consideration, I was most anxious for the position, feeling it would be especially satisfying after having graduated from Cambridge. Eastman Sheehan had charmed Lord Nuffield sufficiently to become a strong contender and eventually he and I competed to a stand-off and my good friend Tommy Kilner became the Nuffield Professor.
Today Sir Harold Gillies’ portrait hangs beside that of Lord Nuffield at the Royal College of Surgeons, London.

**JOINING THE POSTERIOR PILLARS**

In 1912 Helbing, using a modification of Passavant’s principle, united the posterior pillars to increase the size of the velum by denuding the mesial border of the palatopharyngeus arch and extending this denudation over an intervening portion of the free border of the velum. An incision was then made on each side dividing the posterior pillars at the little “x.” The denuded edges were united in the midline by suture aided by lateral relaxing incisions.

In 1944 Harold S. Vaughan of New York Post-Graduate Medical School resurrected Passavant’s principle and published his modification. His logic was impressive:

It must be understood that the palatopharyngei cannot be used to obtain sufficient horizontal elongation of the soft palate to permit elevation against the pharyngeal wall, as these muscles pass down the lateral wall of the pharynx somewhat posteriorly; they can, however, be made to move closer to the posterior pharyngeal wall and, by the assistance of the pharyngopalatine sphincter, the muscles will approximate close enough to nearly close off the nasopharynx. In attempting midline union it is necessary to obtain complete immobilization of the palatopharyngei, and it is here that the silver ribbon is invaluable.

**SANVERNO-ROSSELLI**

Gustavo Sanvenero-Rosselli, a learned Italian of Milan, who accumulated a remarkable private plastic surgery library, often
revealed his knowledge of history. In 1971 he informed me that Paré, or one of his colleagues of that era, had exclaimed of a cleft palate that when the child was born, God was yawning: "Ceux à qui Dieu a bâillé des leur nativité."

In 1949 Sanvenero-Rosselli also advocated the principle of approximation of the posterior pillars of the fauces behind the uvula and in 1958 described the method at the Universities of Turin and Milan. In 1964 in Hamburg he emphasized his enthusiasm for this method, explaining it as a simple procedure for further elongating a previously operated velum when the posterior pillars are not too far apart or too thin. As he said:

Without reopening the closed velum, without any additional scar or interruption or distortion of muscular bundles, we obtain elongation of the palate, such as to grant a positive improvement in its functional value.

In 1973 G. Sanvenero-Rosselli was honorary president of the Second International Congress on Cleft Palate held in Copenhagen. Poul Fogh-Andersen as secretary general had the Congress opened with a lur fanfare, explaining that this demonstration was not a new test for velopharyngeal incompetence. He elaborated:

These Danish instruments, made of bronze and called "lurs," are the oldest playable musical instruments in the world. There is something both musical and fascinating about these lurs, manufactured according to an outstanding casting technique 3,000 years ago, apparently always used as a symmetric pair, calling people together, just as you heard two minutes ago, or warning against enemies, maybe announcing religious ceremonies or possibly for entertainment as you will enjoy in a moment.
As soon as the sound of the lurs had faded, Sanvenero-Rosselli and Ernesto Caronni of Milan again confirmed faith in union of the pillars to lengthen the posterior palate 2 to 3 cm. beyond the uvula and added a uvula switch.

In an effort to contribute to a good velopharyngeal closure, the transposing of the uvula from the anterior (oral) face to the posterior (pharyngeal) face of the velum . . . has proved itself to be very effective. . . . Not only do we transpose the uvula, but with it a certain mass of muscle that remains in the cavity as a contractile protrusion, which often is determinant in assuring a good velopharyngeal contact.

In 1976 D. Rosselli and I. Minuto of Rome, in homage to Sanvenero-Rosselli’s memory, reported their use of the posterior pillar union in 120 cases with only 7 not recuperable, requiring a velopharyngeal flap. As further defense for the principle, they cited the 1972 work of J. Delaire, whose study of the normal palate demonstrated that behind the azygos muscle, situated below the palatopharyngeus, there is a considerable portion of the velum. On this basis he concluded logically that the reconstruction of the cleft soft palate must unite the muscular elements in the most natural way, and thus union of the posterior pillars reconstituted a condition similar to the normal.

In 1954 George T. McCutcheon, of Columbia, South Carolina, reported his use of Passavant’s principle at the time of cleft palate closure:

For some time we had considered the pharyngo-palatine muscles with the idea that their approximation in the midline would accomplish a muscular barrier to the onrush of air into the nose. . . . Since 1949, we have operated upon 75 cases. . . . The results have been encouraging. . . . Most have required no speech training, while a few have accomplished normal speech with minimal training.

Alberto Albertengo of Rosario, Argentina, in 1964 at the International Congress in Rome described his use of Passavant’s union of the posterior pillars. He diagramed with a broken line the edge incisions extending beyond the uvula along the inner border of the posterior tonsillar pillars.
Out of 150 cases, 95 percent had been totally or partially successful. Several final results are shown. He summarized his reasons for continued use of this approach.

1. This type of operation allows the palate to be lengthened a further 2 to 3 cm.
2. A dynamic and effective sphincter is obtained between the naso- and oropharynx.
3. The movements of the palate are not affected. . . .
4. The quality of speech is found to be in direct relationship to the length of the palate obtained.
5. Because the technique is simple it can be done in the same time as the closing of the cleft.
6. If this operation is done in childhood, better results are obtained.
7. When operation takes place at early age, muscular action, in time, lengthens the short palate.

Radiographic demonstration of dynamics of the soft palate after operation: A-A’, Relaxation; B-B’, Activity.
Otto Neuner, oral surgeon of the University of Berne, Switzerland, in 1966 and again at the International Cleft Palate Congress in Copenhagen in 1973, advocated splitting the posterior edge of the velum and extending these incisions bilaterally along the edge of the posterior pillars. Through a crosscut at the level of the tonsil the finger is used to dissect under the lateral pharyngeal muscles and guide further extensions of the incisions in the lateral pharynx. Two-layer closure of the incisions in essence joins the posterior pillars behind the uvula. Neuner noted:

An improvement is attained in creating a new palatine fornix by a lateral detachment of the pharyngeal septum (mainly muscular tissue); the velo-pharyngeal ring is restricted to a narrow lacuna and the new roof shows great flexibility.
The operation was performed by Neuner on 30 patients with a great improvement as regards to consonants but a lesser one as regards to vowels.

Neuner also used what he calls "an Arcus Palatopharyngoplasty," which is a thickening of the posterior tonsillar pillars and diminishing of the velar opening by plication of the constrictor muscle in the fold.

This operation, Neuner reported, either in one or two procedures [was] performed on 45 patients with speech improvement in most cases to normal phonation.

Robert M. McFarlane of the University of Western Ontario, London, Canada, is not unfamiliar with international competition. Not only has he entered the fray in cleft palate surgery, but he represented Canada in the 1948 Olympic Games in London, England, at 400 meters. His best time was 46.9 seconds, which
partly explains the problem he gives his house staff making rounds up and down the stairs of Victoria Hospital's eight floors.

At the 1972 Las Vegas meeting of the American Society of Plastic and Reconstructive Surgeons, he and R. G. Colcleugh presented the most modern "Suture of the Posterior Tonsillar Pillars at the Time of Cleft Palate Closure." He explained closing the palate with a pushback at 1 year with three or four mucoperiosteal flaps as described by Peet in 1961. After closure of the nasal layer of the soft palate, the incisions were made along the medial edges of the posterior pillars and they were sutured in two layers.

A broad web of soft tissue was thus created posterior to the uvula, as shown in his photograph. Here also are his radiographs of a 5-year-old unilateral complete cleft treated in the manner described. (A. Palate at rest, B. Voicing letter e, C. Voicing letter s.)

His summary was pertinent:

The results of this procedure were studied in twenty-three children operated upon for cleft of the palate at one year of age. The study consisted of clinical, radiological, and speech assessment. Eighty-three percent had acceptable speech four to six years later, and there was no evidence of interference with movement of the palate by the sutured tonsillar pillars.
In 1976, after reevaluation, McFarlane reported:

I still feel that it is a good procedure and I continue to use it routinely.

In 1973 at the Cleft Palate Congress in Copenhagen Cardoso da Rocha, a pediatric surgeon of Porto, Portugal, who had been interested in cleft palate for 20 years, advocated the procedure as sketched, noting:

Anatomic reconstruction making use of the pharingo-palatinus muscles facilitates not only a surgical reparation of the cleft palate, but also enables the best phonetics results, avoiding more open "rhinolalias."

In 1974, in the *Journal of the Indian Medical Association*, Murari Mohan Mukherji and A. Chanda of Calcutta advocated tonsillectomy for large and infected tonsils as an aid in surgically uniting the posterior tonsillar pillars during a V-Y palatoplasty. They wrote:

Posterior pillars of the fauces have been stitched up starting from the inferior margin of the uvula for about an inch. The uvula hangs like a ceiling lamp from this elongated soft palate. This partial apposition of the posterior pillars of the fauces not only elongates the soft palate but also constricts the nasopharyngeal aperture. Both these acts help in closure of the nasopharynx for the production of satisfactory speech.

**Votes Against These Unions**

The principle of uniting the posterior pillars of the tonsils has never appealed to me. It may give superior-inferior velar length but does not, in my opinion, give the coveted anteroposterior
lengthening. In our Miami cleft palate clinic in November 1976 we were discussing a patient who had had the posterior pillars united behind the uvula years before in another unit. The speech was poor. David Dickson, our speech analyst, was asked how he felt about the physiology of the pillar union. He expressed disdain, explaining that it might aid swallowing by extending the swoop of the funnel, but in speech it reduced the resonance by dividing the oral and nasal cavities at the wrong point and actually was detrimental to velar movement because of the inferior tethering.
25. Early Crude Palatal Pushbacks; Transverse Releasing Incisions

Roux

In 1825 Roux used a transverse incision on each side of the cleft through full thickness of the velum, extending outward to the pterygoid plate. This released the palate from its attachment to the palatal plates and facilitated closure of the soft palate cleft.

Passavant

In 1878 Passavant designed a pushback of the palate. Lateral incisions 1 inch long on each side mesial to the hamular process and running forward parallel with the alveolar margin were
joined with a transverse incision across the palatal mucoperiosteum. The quadrilateral flap thus inscribed was freed from the underlying bone. The entire velum was displaced backward and held with sutures to the posterior pharyngeal wall. Defects in the hard palate were closed at a subsequent operation and, according to Passavant, this procedure produced satisfactory results. Yet he eventually turned to an obturator.

In 1879 Passavant advanced the velum backward by a transverse buttonhole incision maintained with a stud-shaped obturator similar to the collar-button obturator previously designed and used by Gariel.

In 1886 Gussenbauer is reported to have made a transverse through-and-through incision at the junction of the soft and hard palates which he closed longitudinally.

**SMITH**

H. L. Smith of Nashua, New Hampshire, did a palate pushback procedure in 1895 that permitted the velum to touch the pharynx. Two mucoperiosteal flaps with their bases posterior were dissected from the bone and cut free from the edge of the hard palate to allow a true lengthening. The edges of the cleft velum were freshened and joined by sutures in the posterior position. The remaining mucoperiosteum was freed as two flaps, based anteriorly, and swung medially to unite in the midline and join the pushback flaps. This was the precursor of the four-flap pushback of Wardill.

**GRIFFITHS**

Another pushback, by Joseph Griffiths of Cambridge, England, in 1913 separated the mucoperiosteum from the hard palate, carrying the lateral incisions right forward until they reached the edge of the cleft alveolus. They were united after paring without tension, but the surgeon was not concerned that these loose flaps did hang down onto the tongue for a time. This and the pushback of Smith are the predecessors of the V-Y.
In 1918 J. B. Roberts of Philadelphia used a curved incision across the palate vault in the region of the canine teeth and elevated the mucoperiosteum, freeing the velum. The mucoperiosteal apron thus furnishied, suspended from the hamular processes, allowed the velum to be displaced backward like a sling and held with sutures. This was a predecessor to the Dorrance horseshoe-shaped pushback.

The best known of the early true pushback operations was that of Gillies and Fry. In 1919 when Gillies first became interested in cleft palate, there were three methods in general use: Lane, Brophy and von Langenbeck. On his first visit to study Lane’s work, Gillies gazed with awe at the skill of this master. On subsequent visits he began to see that the large raw mucosal flaps turned to close the gap were responsible for a tight, scarred palate, maxillary distortion and poor speech. Brophy’s principle of compression did not appeal to Gillies because he had already abandoned the concept of pulling together an otherwise normal arch in order to close the maxillary gap, and even then it was evident that unoperated palates had relatively normal occlusions of the uninvolved teeth. The von Langenbeck operation produced a short palate which was too tight in wide clefts.

By this time his dental friend Kelsey Fry, who had joined him at the Plastic and Jaw Unit at Aldershot, England, had demonstrated the ease and efficiency of dental closure of traumatic gaps in the upper jaw.

Before joining Gillies, Fry had had a pretty lively time as a regimental medical officer in the front lines during World War I, receiving the Military Cross and eventually a knighthood. As Gillies and I wrote in 1957:

At Festubert, he dragged a wounded colonel across no man’s land, picking up a sniper bullet in his own arm. Then he experienced a tragedy which probably had a part in saving many a life thereafter. A young lieutenant, who had his jaw blown out during a night raid, staggered into the dugout...
soaked in blood. Captain Fry led him along the trench to the aid station, forcing the lieutenant to lean on him, keeping his head forward to allow blood and bits of bone to fall free of his airway. The lieutenant was turned over to the medical orderly and as his condition seemed good, Fry started back up the trench. He had not gone fifty yards when word came the lieutenant was dead! Investigation revealed the lieutenant had been laid on his back on a stretcher and died immediately of respiratory obstruction. Fry had to wrap him in a blanket and bury him in the mud that night.

He subsequently started a warning campaign to the troops about the importance of keeping the face down and the airway open in mouth and jaw wounds, just as recovery room personnel today care for postoperative cleft palate patients.

Gillies and Fry worked together in friendly cooperation during the rest of the war and were responsible for many advancements in plastic surgery. After the war they set out together to try to design a combined method that might let the cleft palate patient not only speak well and eat well but look well. They published their pushback operation in 1921. By separating the soft palate halves at their junction with the hard palate, but retaining the levator action, Gillies pushed back these halves as far as possible and joined them into a new soft palate able to touch the pharynx in an efficient sphincter. Fry constructed an immediate apparatus to stretch the soft palate during the healing phase and later covered the hard palate defect with a plate and fitted an obturator in the gap between the hard and soft palate.

Their first patient was Bill Booker, who got a 100 percent speech result. Twenty-nine years later, Sir Harold Gillies was scheduled to speak on cleft palate at a meeting at the Royal College of Surgeons, Lincoln’s Inn Fields, London. He sum-
moned Booker and secretly planted him in the back of the audience. At the end of the lecture Gillies called on Booker at the back of the room, and they had a to-and-fro conversation during the entire extent of which not one honorable medical member suspected this man of having a cleft palate. Finally Booker removed Fry’s great obturator and passed among the astounded crowd with his mouth wide open, revealing the large hole.

Subsequent refinements which reduced contracture and produced more mobile soft palates included mucosal flaps turned off the hard palate to be folded over the posterior edge of the soft palate and Thiersch grafts on a gutta-percha dental mold to cover the raw areas on the hard palate.

When I joined Gillies the first time in 1948, he let me do a Gillies-Fry pushback on a short, scarred secondary palate in a veteran who had been the British Army lightweight boxing champion during the Egyptian and Italian campaigns. After a cap splint had been fitted (A), the soft palate was divided from the hard palate along its posterior edge, producing a gaping hole (B). An obturator carrying a split-skin graft, raw surface out (C), was fixed into the hole, and later an obturator was constructed to fill the hole and maintain the soft palate pushback (D).
The method definitely pushed the soft palate back with greatly increased length, but, obturator or not, I hated the hole. Of course, the main drawback to the Gillies-Fry procedure was the necessity of an obturator. Gillies admitted there were pros and cons, and two cases are cited.

**Pro**

The enormous weight of the obturator and denture required by the Gillies-Fry pushback in one woman golf champion, besides providing nearly perfect speech, perhaps helped her keep her head down in putting and her eye on the ball!

**Con**

There was one patient who had had a Gillies-Fry pushback and a Wardill pharyngoplasty, but the boy’s speech, particularly the sibilants, did not improve according to expectations. He could blow a trumpet, but his inability to reach certain high notes was extremely trying to listeners. Gillies recalled in 1953:

Then in the North African desert in 1945, his obturator broke and the Engineer Corps sent it back to him with a marked ridge at the weld, 3/4 inch back from the centre of his teeth. This was the very “talking point” his tongue had been looking for—his speech is now almost perfect.

One case of a Gillies-Fry procedure remains unforgettable. The patient’s name was Ernie Jackson, and the case history began during St. George’s Grand Challenge Cup at Sandwich, England, where in a field of 80 Harold Gillies tied Roger Wethered. They were playing it off on Sunday and broke even the first two holes. The tension was mounting as there came a holdup at the third tee. During this temporary delay the local doctor came out of the spectators and, sidling up to Gillies, whispered:

Would you mind, sir, having a look at one of my patients?

This is Gillies’ account as he reminisced years later:

As there seemed to be some time before we could tee off, I went with the doctor to meet Ernie, who was a 15-year-old caddie with a very tight upper lip.
During the introduction, Ernie hung his head and mumbled a greeting through his nose. Without looking into his mouth, Gillies could imagine the short scarred palate, trying in vain to reach the pharynx. Eventually, a buccal inlay freed Ernie’s lip and nose, a Gillies-Fry pushback freed his palate and a denture with an obturator had a remarkable effect on his speech. As Gillies recalled:

From that time forth, I was never allowed to golf in the vicinity of Sandwich without Ernie as my amended caddie.

In fact, Tom Webster, celebrated British cartoonist and friend of Gillies, combined Gillies’ famous high tee with Ernie the caddie in a 1924 sketch.

Then more sophisticated pushbacks achieved lengthening without an obturator and Gillies saw his procedure discarded like an old shoe. He admitted in remorse:

I felt that I had unnecessarily condemned my palates to an obturator life with all its attendant difficulties.

Thus, when Gillies began putting tube pedicles into the palate in the early 1950’s, we wrote:

One obvious group of tube pedicle candidates are all Gillies-Fry cases, condemned to wear a huge obturator, which necessitates constant dental supervision, irritates the nose, often lodges food and, when the teeth are gone, will not stay up in position. . . . While the dental obturator is in, the patient may be the life of the party, but upon its removal he becomes a social outcast.

After over four decades of brilliant service to his country and the College, one might expect that following his death Sir Harold Gillies’ portrait would be hung in the front hall of the Royal College of Surgeons, along with such of his friends as Sir Gordon Gordon-Taylor. Yet Gillies, only able to suffer formality for short periods and always game for a good-humored prank or a pint of bitters with the boys, would not have had it that way. Thus, if you climb several flights of stairs and pass through numerous back corridors, you will come upon a bar frequented by Fellows in the College and most often by the younger mem-
bers. It is here that Howard Barron’s portrait of Sir Harold hangs, and on his right is the portrait of Lord Nuffield, a longtime friend of his and of plastic surgery.

The other member of this dynamic duo, Sir Kelsey Fry, with his skill at constructing effective obturators, made primary veloplasty possible but saved many maxillae from collapse. Margaret Hotz recalled how he had said that if he had a cleft, he would want the soft palate closed but would allow the hard palate closure only if it caused no forward pull on the velum. During his later years Fry found great enjoyment in growing carnations—not the usual odorless reds and whites sold commercially, but special ones giving off especially fine perfume.
26. Refining the V-Y Palate Retropositioning

GANZER

In 1920 innovative oral surgeon Hugo Ganzer of Berlin pointed out that the von Langenbeck operation left the patient with a short velum. He also noted that paring the edges wasted a valuable 2 mm. of tissue. Therefore he designed a closure in two layers after splitting the edges. He was the first to execute a V-Y type of retropositioning of the palate with a gain in the overall length of about 1 cm. This principle was to have an important influence on palate surgery.

HALLE AND ERNST

Franz Ernst pointed out that in the cleft palate patient the nasopharynx was wider and the maxillary halves were smaller than in non-cleft patients. He observed too that the nasopharynx in cleft palates was longer in the anteroposterior dimension. Then Halle, in a paper to the Laryngological Society of Berlin in 1922, noted that the usual cleft palate operation produced a shortened palate. He reported that since 1915, following the suggestion of Ernst, he had been retropositioning the palate 1.5 to 2.0 cm. Ernst had proposed that a circular narrowing of the pharynx could facilitate the velar approximation to the pharyngeal wall. In 1925 Halle published further details of this procedure.

The edges of the cleft were split for a two-layer closure. The long lateral relaxing incisions were made from the incisors to
well behind the last maxillary molar tooth and extended back and down to terminate in the palatopharyngeal arch mesial to the last mandibular molar tooth. An elevator was introduced into the space of Ernst behind the superior constrictor muscles of the pharynx; the space dissected was packed with iodoform gauze to push the lateral walls of the pharynx medially. The gauze was changed from time to time until the cavity had filled with granulation tissue. During this phase the mucoperiosteum behind the central incisors was divided in two stages (dotted line) with small incisions until complete release allowed posterior displacement. The celluloid plate of Ernst was used to protect the palate during the healing phase.

In complete clefts of the palate, Halle and Ernst carried out the same closure and radical release with subpharyngeal wall packing but used the *V-Y incision* of Ganzer anteriorly for more posterior displacement.
Victor Veau was born in a small village of Burgundy in 1871. He was a poor student in school but brilliant in the Medical School of Paris, and became assistant to the pediatric surgical service of Jalaquier. Disenchanted with von Langenbeck’s palate operation, he became one of the true innovators of cleft lip and palate surgery.

As early as 1922, with Ruppe, Veau advocated the Ganzer V-incision. With ingenuity and dedication, he operated on an astounding number of clefts. His two major contributions still stand as important milestones in the progress of palate surgery: his nasal mucoperiosteal closure of the hard palate cleft, including the vomerine flap, and his suture musculaire. These were described in detail in his elaborately illustrated 1931 book, which recorded 500 personal cases.

He condemned the Axhausen method and then leveled a scathing attack on von Langenbeck:

Langenbeck’s method results in short immobile palates due to sclerosis caused by cica-trization of a large bleeding surface on the nasal aspect of the palate which, in turn, is related to the wide undermining necessary in order to lower the flaps.

He backed his attack with final proof, by analysis of his results by his speech therapist, Mlle Borel. She reported speech effects twice as good as any published by von Langenbeck.

A counterattack was led by a formidable antagonist, Erich Lexer, another of the German giants of surgery. In 1927 he
condemned Veau's principle of suturing the nasal mucosa, arguing that leaving an open wound on the nasal side maintained drainage and prevented the accumulation of pus between the united muscle layers of the palate.

Preferring his own modification of the von Langenbeck method, Lexer referred to Veau’s procedure as the French method which works only for Frenchmen who speak with the mouth but not for Germans who speak with the throat.

Veau, suspecting that Lexer had never tried his method, sent him a copy of his Division Palatine with an invitation to come to Paris. Lexer responded, "I shall not cross the Rhine!" It was then that Veau, with his typical savoir faire, sent a Parisian invitation to Mrs. Lexer and their two daughters. In 1932 all the Lexers crossed the Rhine! They were wined and dined in Burgundy and then taken to Paris, where Lexer was shown an astounding number of clefts collected for his examination. Mlle Borel played impressive comparative sound tracings recorded on the patient's diction preoperatively and postoperatively. Led to the operating room Lexer then was assisted and supervised in a Veau palate operation by Veau! The following year, when Veau visited Lexer in Munich, he found that the great German surgeon was using his method.

Veau's first-stage closure turned vomerine flaps for nasal lining and mucoperiosteal flaps to overlap partially this one-layer clo-
sure. In the second stage or in soft palate clefts, Veau used a modified Ganzer V-Y closure of the oral mucoperiosteum without actually lengthening the nasal mucosa or dividing the posterior palatine vessels. He placed a metallic suture around the muscles with a Reverdin needle.

LeMesurier

In 1935, in the Canadian Medical Association Journal, A. B. LeMesurier of Toronto published his use of Veau’s operation in incomplete clefts of the palate and in complete clefts.

Veau’s influence was worldwide, and his general principles are still popular today.

Personal observation

In the summer of 1948 I went over to the Continent for a month and in 1950 recalled:

In Paris, not far from Gare St. Lazare, I found the flat of Victor Veau. A saucy French maid ushered me into a dimly lighted room with the curtains drawn. I was left to feel my way along the wall and finally sat down, not without a start, on a lion skin with its snarling head draped over a couch. Presently, the gaunt and ailing Veau, in silk robe and gray goatee, came rushing in, kissed me on both cheeks, gave me three reprints written in French, a requested photograph of himself and invited me to return again one day. I did not even get a chance to ask if he still used wire for his “suture musculaire.”

At l’Hôpital Saint-Michel, where Veau did much of his later palate work, I found Jacques Récamier. He explained that Veau’s
lip and palate technique, except for insignificant detail, had not changed for many years. In fact, the technique I saw Récamier use seemed identical to that described by Veau in 1927.

Less than a year later, on May 16, 1949, the sympathique Victor Veau had died of the illness incapacitating him during my visit. All the cleft palate world mourned his passing. Jacques Récamier at l'Hôpital Saint-Michel and Pierre Petit at l'Hôpital Saint-Vincent de Paul carried on his great work.

PETIT

At the 1964 Hamburg International Symposium, Pierre Petit of Paris, once a student of Veau, described the method he used as that of Veau with a few changes. He outlined the different stages of the procedure:

1. The medial edge of the soft palate is divided longitudinally
2. The two palatal mucoperiosteal flaps are dissected and the two neurovascular bundles elongated
3. The hamuli are infractured. The palatal aponeurosis is detached and the nasal mucosa liberated and pushed medially.
4. The dorsal [nasal] mucosal layer is closed (from the anterior to the posterior part) by catgut sutures, leaving the knots exposed nasally
5. The buccal mucosal layer is closed and muscle simultaneously sutured from back to front with silk mattress sutures. Then the mucoperiosteal flaps are fixed to the roof of the osseous palate to avoid any dead space.

LIMBERG

In 1926 at the convention hall in Philadelphia an International Dental Congress was held, and many famous palate surgeons—Brophy, Gilmer, Ivy, Blair and Brown—were there. Dorrance explained his 1925 pushback procedure. Then a Russian named Alexander Limberg presented a variation of the V-Y pushback, which he published in 1927. Limberg used the Halle-Ernst design with the Ganzer V-incision and Blair's soft palate release(x), and advocated interlaminal osteotomy of the pterygoid process and pterygomaxillary osteotomy. He criticized Halle and Ernst for dividing the posterior palatine vessels and nerves. To facilitate the lengthening maneuver and preserve the neurovascular bundles, he proposed ostectomy of the bony palate wall of the foramen with
a chisel or bone-cutting forceps, removing a section of bone mesially and posteriorly. This ostectomy of the posterior wall of the foramen enjoyed popularity for many years and even today is used in some clinics.

In 1959 I had a chance to visit Limberg in his Leningrad clinic, see his patients and discuss his method of lengthening the palate. He was most proud that he postponed final palate surgery until about 10 years of age to protect teeth and maxillary growth, a conservatism natural in a surgeon with his dental background.

**WARDILL**

William Edward Mandall Wardill had become intrigued with the problem of cleft palate during his association with Professor Gray Turner. Turner’s speech results were appalling, and his claims of a considerable proportion of “normal speakers” appeared dishonest. Cognizant of Turner’s high integrity, Wardill suddenly realized that the professor was hard of hearing and not acute enough to pick out the faults in the speech of his patients. Wardill began to study the anatomy and physiology of normal and cleft palate individuals. In 1928 he described a palatal insertion of the superior constrictor muscle of the pharynx. It was confirmed two years later by anatomist Whillis, who labeled the pterygopharyngeus portion of this muscle inserting into the palate the “palatal pharyngeal sphincter.”

Wardill, however, continued to follow the teaching of Gray Turner and cut his flaps according to the von Langenbeck method but adding his “transverse-to-longitudinal” pharyngoplasty. He spent hours trying to teach his patients to speak correctly, and finally it became obvious to him that a better surgical design was needed. To get the best results, he felt, the operation should be carried out before speech age since once the patient learned incorrect speech habits the difficulties increased a hundredfold. Yet this early surgery seemed unattainable at the time since Ian McGill had not yet developed endotracheal anesthesia.

Over the next few years Veau’s influence had extremely beneficial effects across the Channel, for by 1937 Wardill in Newcastle upon Tyne and Kilner in London upon Thames independently
published more radical and perfected V-Y retropositioning operations than what had originally been described by Veau. Whether justifiably or not, more often than not this principle bore Wardill’s name. Yet Kilner’s rendition probably enjoys more popularity today. Wardill and Kilner remained friends through it all.

In 1937, in the widely read and respected *British Journal of Surgery*, Wardill, following Veau’s suggestion that raw surfaces should always be covered (at least over parts concerned with the movement of the soft palate), described his dissection of the mucosa from the nasal surface of the hard palate edges. He fractured the hamulus, divided the posterior palatine vessels and modified Ganzer’s V-Y by transecting the mucoperiosteal flaps in their mid-length to ensure adequate blood supply. By freeing and stretching the nasal mucosa, he obtained about 1 cm. in apparent length at the operating table. He used a three-flap method for incomplete clefs. Then, for a complete cleft, he chose a four-flap procedure, shown here in detail, continuing to use his pharyngoplasty in conjunction with his semi-lengthening procedure.

As I wrote in 1950:

Socialized medicine was scheduled to take over in Great Britain July 5, 1948. As this time approached, it was rumored that Wardill was emigrating to South Africa. When it was reported he was finishing up his waiting list of prostates and palates, I caught the night train to Newcastle and was waiting in his nursing home. Luckily it was a palate day. He arrived in high rubber boots, said “If anyone has just cause why these two palatal edges shall not be joined together, let him speak now or forever hold his peace,” and proceeded to do a V-Y closure. I noted the main differences were that he hummed while he worked, divided both posterior palatine vessels and did a pharyngoplasty routinely on all cleft palates.
Wardill and his magic carpet

When socialized medicine finally did take over, Wardill packed up, took flight and landed, to everyone’s surprise, at the Royal Medical College in Baghdad. Wallace Steffensen, interested in just how effective lengthening operations really were, traced Wardill to Iraq and extracted his latest thoughts in 1952. Wardill admitted using his pharyngoplasty in all cases since it had done no harm. When asked if he still used his Y-Y retropositioning procedure, he answered, revealing his bias for judging cleft palate operations by their speech results:

Up to the present time the operation I described produces the best speech results and I shall remain of this opinion until someone in the future can produce a new operation and demonstrate by results something that is better.

KILNER

Also in 1937, but in the more local St. Thomas Hospital Report and then in Postgraduate Surgery, T. Pomfret Kilner described a remarkably similar and possibly better procedure. The important difference lay in his refusal to divide the posterior palatine vessels, depending on freeing them from their attachments around the foramen. He did not consider the pharyngoplasty necessary in all cases. He gave Veau special credit, mentioning

free separation of nasal mucoperiosteal flaps and approximation of these as far as possible throughout the cleft . . . employment of vomerine flap or flaps, when available, to assist in this nasal closure [of hard palate] (Veau).
As he wrote in 1937:

I have freely borrowed from the work of my contemporaries, gradually evolving a procedure which for several years now has been giving me most gratifying results at the Princess Elizabeth of York Hospital for Children, Shadwell.

The essential points may be summarized as follows:

1. Pharyngoplasty (Wardill).
2. Rotation flaps from the hard palate (Veau).
3. Extensive freeing of the soft palate tissues from the posterior borders of the palatal process (but no division of the mucosa!).
4. Hamular process fracture, a procedure introduced many years ago by Billroth and re-introduced by Wardill and certain American workers (Dorrance particularly) in comparatively recent years.
5. Free separation of the lateral pharyngeal wall from the internal pterygoid plate and its immediate neighbourhood (Ernst and Axhausen). . . .

. . . The reference after each is given not as indicating so much the original introducer as the surgeon in whose work I first observed this part of the technique.

Kilner also acknowledged:

Wardill has recently introduced what he has described as a “four-flap method,” and I have found this useful for closing wide clefts which extend far forward.

An Oxford dynasty

Kilner’s meticulously skilled technique, set routine, congenial teaching of the transient foreign student, tyrannical schoolteaching of his own house staff and assistants, aided by the prestige
of his Nuffield Professorial throne at Oxford and its convenience by rail and road from London, brought him a stream of students, old and young. Those who came to watch returned home inspired to try to duplicate Kilner’s precision. As Marcks, Trevaskis and Tuerk of Allentown, Pennsylvania, stated in 1955:

Soft palate clefts and partial hard palate clefts are repaired exactly as described by Kilner.

Even at his last palate operation before his retirement, as seen in a memorable photograph kindly sent me by Kernahan, Kilner was surrounded by observers. It is interesting to see him in his characteristic seated position with the patient’s neck extended and his head reclining almost in his lap.

More important, he produced a dedicated core of second-generation captains who have carried out the tradition of the V-Y Corps to the third, and now even the beginning of the fourth, generation. Kilner kept fastidious records, but balked during his later years at the task of compiling these into a book, and the same task has been bypassed by others. Possibly a fifth-generation surgeon will go back and correlate the vast experience recorded by Kilner at Oxford and Alton.

**Personal experience**

By 1948 I was training with Gillies, but since his palate surgery was confined mostly to secondary work, I used weekends, holidays and odd times to visit other palate surgeons.

Every other Saturday, Kilner and Peet took off from Oxford to put on an exciting cleft lip and palate show at Lord Mayor Treloar Children's Hospital, Alton. From Basingstoke it required a two-hour ride on a red double-decker bus through English countryside to arrive for the morning clinic. Here Professor Kilner, with a carnival blower and an attentive ear, demonstrated the excellent velopharyngeal closure and speech results of his palates. "What is this, little boy?" asked the professor, pointing to a cigarette and listening for the coveted sound of “s.” "Fag!" said the complete group III bilateral cleft lip and palate, grinning on his slightly prominent premaxilla. It was estimated that 80 percent of his palates could pronounce s quite nicely.
In the operating theater when the genial little professor sat down to a cleft palate, all nationalities collected about him like drones buzzing around the queen bee. I became quite adept at working my way through the Indians, Italians, Belgians and British in order to see a technique carried to its perfection. Kilner reveled in honing a routine to regimental precision. Once I was allowed to scrub in as first assistant and experienced his knuckle-cracking instruction, as he indeed turned into a tyrant when in the theater.

It was thrilling to watch Kilner or Peet develop the V-Y flaps, stretch the posterior palatine vessels out of their foramen, dissect the nasal mucosa from the medial pterygoid plate and along the posterior border and free edge of the hard palate. This freeing of the soft tissue from the bone, which the professor called "filleting," when completed on one side revealed at least a temporary gain of 1 cm. in length as compared to the unoperated side. Emphasizing the importance of this dissection and his preference for it, Kilner would describe how he had observed Victor Veau place his "suture musculaire" and then cry "Tirez! Tirez!" as he dragged the palate halves together with force. One of the most disciplined aspects of Kilner's surgery was his suturing. He used the French Reverdin needle, which although a little too big for fine suturing was extremely well adapted for awkward closure of the nasal and oral palatal mucosa. He would place an entire row of sutures for one layer and hang them in an orderly array on the spring coil on his gag. Then he would tie them all and cut the ends before placing the next entire row of stitches.

**REIDY**

Joseph P. Reidy, a student of Kilner, presented as his Hunterian Lecture in 1957 an exhaustive study of 370 personal cleft lip and palate cases. He favored Kilner's V-Y retropositioning and, comparing it to von Langenbeck's method, said:

It must appear obvious that detachment of palatal flaps anteriorly will allow more movement of flaps in a posterior direction in the V-Y procedure.

He reported some interesting statistics on the primary use of the V-Y palate procedure: In 1949 Oldfield (another Kilner student)
reported 113 cases with 61 percent normal speech, 32.8 percent fair; in 1957 Reidy reported 193 cases with 77.2 percent normal speech, 20.2 percent fair.

Reidy concluded with the observation that the plastic surgeon is concerned with early palate repair and normal speech, while the orthodontist bemoans alveolar collapse following early palate surgery. Meanwhile the parents worry about appearance. The patient is in danger of becoming a misguided missile moving back and forth between the surgeon and the dentist. Reidy suggested that the orthodontist and surgeon change places in time:

Early correction of the arch deformity [should be] followed by later repair of lip and palate.

Pigott, who trained under Reidy and gained much from his discipline, recalled:

Reidy was enormously experienced, quick, methodical, unquestioning of Kilner dicta. I never saw him make a palate fistula in five years. When I would be absentmindedly sucking up blood somewhere away from the field he was working on, he'd say, "Suck, suck, suck, no, suck here—use it like a search light, not a vacuum cleaner—I can get charwomen at ten a penny."

In 1962 Reidy set 1 year as optimum time for palate closure, Kilner V-Y retropositioning as the primary procedure and Hynes pharyngoplasty as the secondary procedure of choice. Under these circumstances he recorded a failure rate of 20 percent and noted:

There is no doubt that scarring following breakdown, minor perforations, or repeated surgery plays a great part in reducing mobility of the palate.

PEET

Eric Peet, who was trained by Kilner, (and became his heir as director of the Nuffield Department of Plastic Surgery at Oxford), perfected the Kilner method. He executed his surgery with the same precision that he used in constructing stringed instruments in his free time, his last remarkable feat being the completion of a quartet of two violins, a cello and a viola. Peet presented what he termed the "Oxford technique" to the American Society of Plastic and Reconstructive Surgeons in 1961, citing his 500 cases of primary palate repair over the previous 20 years. As he explained:
Most of us are influenced by our early teaching and by those men we respect, under whose guidance we have served our early apprenticeship. . . . One's tendency has been to try gradually to improve the technique rather than alter it.

Quite lucidly, he described the paring of the cleft edges, stab incision and fracture of the hamulus with a Cumine's scaler, V-Y mucoperiosteal incisions and dissections of the mucoperiosteal flaps from the bone, mobilization of the nasal mucosa with the sharp and blunt crochet and Wallis's finisher, better known as the "golf club." He emphasized the importance of the dissection of the muscles medially from the medial plate of the pterygoid down to the base of the skull and the division of the palatal aponeurosis along the edge of the hard palate to give the backward release. The effective lengthening is seen after one side has been dissected.
The first suture in the closure, destined to be the anchoring stitch, was a 3-0 chromic catgut mounted on a small, curved Reverdin needle and passed through the nasal mucosa anteriorly. The nasal layer was then closed, and mattress suturing of the buccal layer followed. The final key tie was a figure-of-eight of the anchor stitch. Iodoform gauze packing was inserted on the medial side of the medial pterygoid plate.

The four-flap method was used for clefts extending well forward in the hard palate and for complete clefts after the anterior portion of the cleft had been closed previously with a Veau vomerine flap.

It was also used for complete bilateral clefts, the vomerine flaps being employed for nasal closure.
With this technique Peet reported, in 1961, 82 percent normal speech results in a series of 107 patients operated on between the ages of 12 and 15 months.

**CALNAN**

Another of the elite Kilner Corps is James Calnan, professor, Royal Postgraduate Medical School, Hammersmith Hospital, London. A critical thinker with a bit of the rebel in him, he sometimes enjoys challenging accepted tradition. While still at Oxford under Kilner in 1954, he sided with Veau to destroy the myth of the importance in speech of Gustav Passavant's pad.

For the fine book by Grabb, Rosenstein and Bzoch published in 1971, Calnan described each step of the Kilner V-Y palate operation previously presented by Peet, in identically meticulous detail. One variant was his preference for the spoon-shaped Mitchell trimmer for hamular fracture and flap elevation. Also, in one of his diagrams during the early suturing, Calnan shows the limited extent of the actual posterior lengthening following complete dissection—the shaded distance between the hard palate edge and the folded-back mucoperiosteal flap.

It is of interest that in 1960 Calnan questioned the consistent effective long-term lengthening achieved by the V-Y pushback. In 1971, after 245 cleft palate operations on infants, Calnan reported a mean age of 13.4 months and an incidence of fistula at the posterior border of the hard palate of 11.4 percent. Speech
results were assessed at 75.5 percent ± 2.74 with normal articulation and 64.4 percent ± 3.06 with no escape of air down the nose (mist on mirror). As to actual posterior lengthening, Calnan is a little more optimistic:

However, a radiological study on a limited series of adults with cleft palate has shown that some lengthening of the velum is obtained, although the amount is usually less than 8 mm. Perhaps of greater interest was the finding that the amount of lengthening obtained at operation was inversely related to the original length of the soft palate.

**INNES**

Frank L. F. Innes of Norwich, England, is also a member of this elite line, having had both Kilner and Peet as his mentors and having been influenced by Calnan, another of their students. In 1976 he wrote:

The operation which I have always done for the primary repair of the cleft palate is the Kilner-Wardill operation and I am satisfied with this procedure. This operation does not push back the soft palate very much, but it does permit the soft palate to rotate upwards towards the roof of the nasopharynx. The maximum upward rotation is obtained if the palatal muscles are freed deliberately and radically, not only from the hard palate but also from the nasal mucosa... The upward rotation of the soft palate enables it to make firm contact high up in the nasopharynx, which is where its point of contact in the young child should be. In older patients the soft palate makes contact with the posterior wall of the pharynx at a lower level, a little above the line of the floor of the nose... If a surgeon has a failure rate with speech of more than 15–20%, he ought to question the type of operation which he is doing and whether he is doing the operation at the optimum age. I am unable to offer a definition of speech standards, but I find it hard to accept a result which is in any respect short of normal.

**BATSTONE**

And unto the third generation of Kilner through the teaching of Peet, suave country gentleman-surgeon John H. F. Batstone, living in a sixteenth century Elizabethan cottage (complete with authentic prisoners' stocks) near Oxford University, has taken over as cleft chief at Churchill Hospital where Kilner and Peet
once reigned. Trained in the standard V-Y by Peet but partially uprooted from this routine during 1966 while a Robert W. Johnson Fellow in Miami, Batstone has become what Kilner would have considered enough of a renegade to sentence him to a stint in his own stock. It is true he still champions the V-Y, but, as he said after a ski on Biscayne Bay in Miami in 1977:

The key is flexibility. In the complete cleft I close the lip and the anterior palate at 3 months—using a Stellmach vomer flap for the anterior palate, and rotation advancement for the lip. At 6 months the rest of the hard and soft palate cleft, if favourable, is completely closed by a 3- or 4-flap V-Y retroposition technique. If unfavourably wide, however, then the soft palate only may be closed at this stage, with an interval of several years (with or without a plate) before closing the residual hard palate cleft. Often it is found that the gap has narrowed sufficiently over the years to make a Langenbeck procedure both practical and effective. If the palate is still short, then a V-Y procedure is relevant and one might slip in an island flap at this time. When there is palate involvement only, as in the post-alveolar clefts, then I often revert to the simple Langenbeck method so as to achieve closure with a minimum of dissection and interference. Later on, in all grades of palate cleft where there is a persistently unacceptable degree of "nasal escape" speech, some form of pharyngoplasty becomes obligatory. At present I am not over-enthusiastic about most types of flap pharyngoplasty, but encouraged by use of retropharyngeal silastic implants inserted via a lateral incision.

**V-SPLIT FLAP PUSHBACK**

When there was only moderate shortening of the velum, Hamilton Baxter of Montreal in 1942 combined the Ganzer V-incision with the Barrett Brown horizontal splitting dissection under the mucoperiosteum leaving a layer of scar tissue beneath. He warned that much of the lengthening would be lost following contraction of the raw surface on the nasal side.
VAUGHAN

Nova Scotian Harold S. Vaughan of New York, in 1944 in *Surgery Clinics of North America*, described his method of V-Y pushback in complete clefts. His first two stages involved closure of the posterior part of the cleft, then the anterior portion. This was followed by a variation of the V-Y principle in a two-stage pushback. First he made incisions on either side of the previously closed cleft in the bony palate, leaving a narrow bridge of tissue, and then made lateral incisions along the line of the alveolar ridge through which the mucoperiosteum was elevated. The mucoperiosteum was replaced and held loosely by sutures for three or four weeks.

Then Vaughan re-elevated these two mucoperiosteal flaps and divided them from the palatal aponeurosis, leaving a rim of tissue at the posterior edge of the hard palate. He fractured the hamulus but did not divide the nasal mucosa, consequently limiting his lengthening. Finally he advanced his mucoperiosteal flaps in a V-Y action, suturing them to the midline section of tissue.

HYNES

In 1954 Wilfred Hynes of Sheffield, England, advocated less traumatic V-Y palate closure. He started with a Hynes pharyngoplasty and then outlined the principles of his palate closure:

- a. The attachments of the palatine aponeurosis to the posterior borders of the bony elements of the hard palate are not disturbed.
- b. The lateral pharyngeal dissections are avoided and the levators palati are therefore not exposed.
- c. The anterior attachments of the upper part of the superior constrictor to the hamular processes, to the posterior borders of the internal pterygoid plates, and to the palatine aponeurosis are left intact.
d. The attachments of tensores palati to each side of the anterior part of the palatine aponeurosis are not interfered with.

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**PINTO**

In 1972 H. S. Adenwalla of Trichur, India, wrote of his former chief Charles Pinto's experience with the V-Y palatal procedure:

His execution of the palate was on the well-tried principles laid down by Veau and Wardill and the technical improvements made by Kilner and Peet. In his last year he began to do less and less of the "four flap" operation and began to teach the advantages of the "two long flap" operation which we now call the "Pinto modification of the Wardill repair." This eliminates the weak point at the junction of the anterior and posterior flaps, the commonest site for the formation of a fistula. We in this department do not do routine culture examination on palates. In spite of this we have not had a single fistula in the 57 consecutive cases operated on since January 1971 by this modification. He did not have time to evaluate his own results with this "two long flap" operation, though he anticipated the elimination of breakdown and fistulae. We do not perform the "four flap" operation anymore.
KERNAHAN

Early palatal mucoperiosteal flap dissections have been blamed more and more as possible causes of retardation in maxillary growth with subsequent deformity. The mucoperiosteal V-Y retropositioning procedure has come under slightly more fire than the von Langenbeck operation. At the Cleft Palate Symposium in Chicago in 1977, Desmond A. Kernahan, a Kilner disciple and now chief of plastic surgery at Children’s Memorial Hospital, Chicago, argued that there is no convincing confirmation of a difference in maxillary development following the von Langenbeck and the Kilner-Wardill V-Y pushbacks. He stated frankly that the only differences were better exposure with the V-Y as the flaps are elevated and facilitation of the dissections by easier access under direct vision.

DEMJEN

Gentle Stefan Demjen of Comenius University, Bratislava, Czechoslovakia, came to England in 1948 to study with Gillies. He and I became friends and spent many a Saturday at Lord Mayor Treloar Hospital, Alton, watching Kilner and Peet adroitly execute their V-Y palate operation. Demjen was an experienced general surgeon with dexterous fingers that enabled him to pick up plastic surgery techniques quickly. During his sojourn at Iowa University before his final return to Bratislava, he developed his modification of the W-V-Y palate retrodisplacement operation and wrote a learned thesis in its defense. The Bratislava Project thoroughly evaluates the method.

Demjen noted that Kilner, Peet, Reidy and Osborne did not divide the posterior neurovascular bundles, and consequently their pushbacks were limited. He wrote:

In 1951, I decided to produce maximum possible elongation of the soft palate by severing the neurovascular bundles. . . . Professor Burian and I made a sort of agreement. He in Prague would preserve the bundles and I in Bratislava would cut them, and after 5 to 10 years we would compare results.

Demjen quoted Arthur Barsky’s 1964 book:
While V to Y and pushback procedures are capable of achieving a limited amount of backward displacement, there are two deterrents that prevent the surgeon from obtaining the optimum amount of retrodisplacement: (1) the neurovascular bundle which cannot be mobilized as freely as is desirable; and (2) secondary contracture of any raw surface left on the nasal side. If one could sever the neurovascular bundle, the first difficulty might be solved, but possible complications are so obvious that this step should not be considered (Broadbent and Hochstrasser, 1959).

Demjen then noted:

At the time of reading this statement from a very experienced plastic surgeon, I had already cut the neurovascular bundles for this purpose more than one thousand times without complication in healing, growth or function of the palate.

He defended his stand with anatomical facts:

The anastomoses of the vessels in the nasal cavity and in the soft palate suffice to supply the palate after ligation of the greater palatine artery. This is certainly true in the Wardill-Kilner type of palatoplasty where the oral mucoperiosteum is divided by the oblique incision into two equally large flaps. The anterior flaps retain their blood supply from the nasopalatine arteries and short posterior flaps survive the sectioning of the posterior neurovascular bundles without trace of ill effect from diminished blood supply.

In the descriptions of his V-Y operation, the use of three flaps for incomplete clefts and four flaps for more extensive clefts and the division of the vessels were in line with Wardill's operation. His lateral dissections were similar to those of Kilner and Peet.
His description of this mobilization of the soft palate, accompanied by drawings, was excellent:

This is done by entering the lateral pharyngeal space (Ernst’s space) and detaching the entire soft palate from the attachments to the maxillary tuberosity and medial pterygoid plate. . . . After fracture of the pterygoid hamulus medially and detachment of the superior constrictor from the medial pterygoid plate, the soft palate, along with the tensor palati, the superior constrictor and the mucosa of the lateral pharyngeal wall, can be pushed medially to allow suture of the cleft margins without undue tension. The depth to which the plane between the medial pterygoid muscle and tensor palati muscle is entered must not be too high, because it is in that plane where the nerve of the tensor palati may suffer damage if it is forcibly or too highly entered or packed. (Many years ago, we completely abandoned packing of the lateral pharyngeal spaces.) Twenty-four hours after surgery one does not see any more gap in the tissues in this region. The space is most likely filled in by the tissues of the cheeks.

Closure of the nasal mucosa, if the cleft is not too wide, can be achieved by side-to-side suture, or, if available, the vomerine mucosa can be split and turned laterally to assist in suturing.

BURIAN

In his Plastic Surgery Atlas (Vol. 2), published in English in 1968, Burian presented his rendition of the Veau-Kilner-Wardill four-flap procedure, preserving the vessels, in complete unilateral clefts.

This is his rendition of the same principle for complete bilateral clefts:
Robert McCormack of Strong Memorial Hospital, University of Rochester, New York, was a halfback and safety at Swarthmore College and was one of 20 football players of the 1939 season who later made significant contributions in their careers to be honored by Sports Illustrated with the Silver Anniversary Football All-American Award. Trained by Forrest Young at Rochester, he worked with him on the paper entitled "Arterial Flap Repair in Cleft Palate" which was presented to the American Association of Plastic Surgeons in Ann Arbor in 1949. McCormack describes this modification of the V-Y which he has continued to use:

The major points were the extensive incisions from the retromolar fossa laterally continuing just medial to the alveolus and completely around the anterior end of the long arterial flap, then posteriorly along the edge of the cleft. The design of the flap violated the safe dimensions of a random flap so the major palatine vessels were left intact by careful dissections of the vascular "stalk" and teasing the vascular pedicle from its foramen. After this extensive mobilization of the arterial flaps closure without tension was possible with fine suture material and eversion of the pared edges.

The anterior ends of the repaired arterial flaps were secured by horizontal mattress sutures to a small triangle of mucoperiosteum left at the extreme anterior portion of the hard palate.

This type of cleft palate repair has been continued at the University of Rochester for thirty years. Analysis of results have included speech assessment, bony growth, orthodontic cephalometric follow up and the criteria for any secondary pharyngeal flap surgery. The speech analysis has shown highly satisfactory results in over 80% of the cases.
RUSSIAN V-Y’S

In 1970 A. A. Kolesov gave us a glimpse of Russian repositioning of the palate. First he presented the radical V-Y pushback of Limberg’s method, after Rudko. Then he presented variations of the V-Y retropositioning in complete unilateral clefts (Zausayev’s method).

This is the two-staged design of V-Y procedures for complete bilateral clefts, after A. Khetrov:
All previous V-Y procedures had used mucoperiosteal flaps dissected from the bone of the hard palate to feed into the lengthening of the oral side of the palate. Herfert's rumblings, ignored by the majority, were heard and heeded by a German surgeon, Widmaier, in Stuttgart-Süd.

WIDMAIER

At the age of 20 in 1943, Werner Widmaier of Stuttgart was wounded in the face and jaw in Russia. Treated first in Russia, he was then transferred to a hospital in Tübingen, where Eduard Schmid took over his reconstruction. During his long stay in the hospital he started his medical studies and on vacation assisted Schmid in surgery. As he told me in 1971:

My interest in plastic surgery was a result of my own wounds and living together with many whose faces had been disfigured in the war. It was the possibility of giving back a face to these people that fascinated me. To Schmid, of course, and also to Professor Trauner, with whom I worked a long time, I owe very much. Cleft surgery has always been my favorite field of plastic surgery and still is.

In 1961 Widmaier designed a palate operation which reflected the Schweckendiek influence, avoiding any disturbance of the hard palate and thus any danger of subsequent maxillary deformity, but employing the V-Y principle to provide a soft palate of adequate length and functional competence.

V-Y Lengthening in Soft Palate Cleft

In soft palate clefts, oblique incisions are made at the junction of the hard and soft palate, care being taken to avoid damage to the vessels and nerves. These incisions are released laterally with sharp-angled incisions, which with blunt dissection allow the posterior edges of the soft palate halves to touch the posterior wall of the pharynx. The nasal mucosal layer of the soft palate is elongated by means of the zigzag incisions of Schuchardt. The lateral relaxation defects are closed with the Blair-Schmid transposition flaps from the adjacent cheeks.
Widmaier adopted the Campbell incision for hard palate closure. A long, triangular vomerine flap is detached in the roof of the pharynx and, with its base maintained along the edge of the vomer, is peeled off the bone to span the cleft. A cuff of oral mucosa is turned over in continuity with the nasal mucoperiosteum bordering the cleft to form a lining flap. These flaps are overlapped to achieve a two-layer closure of the hard palate without maxillary disturbance.

At the same operation the V-Y posterior advancement of the soft palate is carried out, and the lateral defects are closed with cheek flaps. The nasal side of the soft palate cleft is lengthened by the zigzag interdigitations.

In the 1974 *Journal of Maxillofacial Surgery* Yugoslavian Milivoj A. Perko of the University of Zurich presented an
operation for isolated cleft palate which he described as basically derived from the Widmaier method. It was indeed another and possibly an even more heroic attempt to prevent maxillary growth impairment by palatal mucous membrane dissection leaving the hard palate mucoperiosteum intact and the neurovascular bundles still attached to the hard palate. In principle, it was a primary palate closure utilizing the freed nasal mucosa as one layer, with a small Z-plasty on its distal portion, correct positioning and uniting of the levator muscle sling, and a V-Y mucosal flap advancement on the oral side.

Theoretically, this plan has many good points. Perko lists them as: (1) intact periosteum with entire coverage of the hard palate bone, (2) greater lengthening without restraining neurovascular bundles, and (3) improvement in muscle position. He also outlined the possible disadvantages:

1. Mobilization of the mucous membrane on the palate is a more difficult technique.

2. The danger of necrosis of the mucosal flap is greater, but should not occur with careful dissection of the mucous membrane. If necrosis should still occur, however, the classical closure with the palatal periosteal flap is always still possible.

Practically, it would seem that the disadvantages would eventually outweigh the advantages. Perko acknowledges only two years' experience with 35 cases, but if after two years he is still happy, then probably so are the maxillae. It is hoped that the distal ends of these mucosal flaps sympathize with the hard palate's getting all their blood supply; otherwise they may simply necrose.

In 1977 Perko explained:

Actually, we perform the mucosal flap only in incomplete clefts or isolated clefts of the palate. In the total cleft we prefer to perform the soft palate closure first and the flap reaches to the first deciduous molar, which means it is longer than in the original Widmaier technique. The dorsal cut of the hard palate becomes closed in this first operation. The hard palate is closed later, in unilateral clefts at the age of 5 to 6 years and in bilateral clefts even later.
As many of the surgeons using lateral relaxing incisions—
including those doing V-Y pushback procedures—advocated deep
and thorough dissection into the space of Ernst for medial dis-
placement of tissue from the pterygoid plates, a warning is in
order.

Ivor W. Broomhead’s 1951 work at Cambridge on the nerve
supply of the muscles of the soft palate, published in the British
Journal of Plastic Surgery, gave some important information about
the dangers of injury during surgery:

In the plastic repair of a total cleft palate an incision is carried forwards from
in front of the palato-glossal arch to the back of the alveolus, and then along
the palatal edge of the gum to curve medially to the cleft margin. A second
incision extends along the free margin of the cleft to meet the first incision
anteriorly. Blunt dissection is performed down to the pterygoid hamulus,
just anterior to the palato-glossal arch, and from this point into the plane
between the medial pterygoid and tensor palati muscles, these muscles being
separated from each other. After fracture of the pterygoid hamulus medially,
the soft palate along with the tensor palati can be pushed medially to allow
suture of the cleft margins without undue tension. The depth to which the
plane between the medial pterygoid and tensor palati is opened up was
measured in one case of a child aged 3 and found to be 2.5 cm. from the
surface of the incision. A series of measurements was made from the tip of
the pterygoid hamulus to the anterior margin of the foramen ovale in skulls
of different ages . . . and it will be seen that the separation of the muscles
extends practically to the base of the skull.

It is in this plane that the nerve to the tensor palati is found and may
suffer damage during this stage of the operation.

The next stage of raising a flap from the hard palate preserves the greater
palatine nerve and artery as it is carried out subperiosteally. Following this,
the palatal aponeurosis is freed from the posterior edge of the hard palate,
and the bone between the greater palatine foramen and the edge of the bony
palate is removed to allow greater mobility of the neuro-vascular bundle to
the palatal flap. Both these stages must result in damage to the lesser
palatine nerves and artery. Section of the lesser palatine nerves would
produce some anaesthesia of the soft palate and, if the musculus uvulae is
supplied by these nerves as appears to be the case, paralysis of this muscle.
The nerves also send branches to the mucous glands of the palate. . . . It
has been shown that at least half the substance of the soft palate is composed
of mucous glands. Any reduction of this tissue, possibly by atrophy of the glands following denervation, would result in a substantial diminution in the thickness of the soft palate and in the size of the uvula. This may have some detrimental effect on the efficiency of closure of the nasopharyngeal isthmus and on speech. . . . At no time during the operation are the nerves to the levator palati, palato-glossus, and palato-pharyngeus likely to suffer damage, as the courses pursued by these nerves are well removed from the operative field. The final stage of inserting a pack between the medial pterygoid and tensor palati muscles could again lead to damage to the nerve supply of the tensor palati.

**LIMITED USE**

The V-Y principle is still popular. Yet as an early primary procedure, although it provides excellent surgical exposure, it requires too much mucoperiosteal elevation, leaves residual raw areas and achieves only modest lengthening. It also burns the bridges for possible later use of an island flap by cutting across the pedicles. For these reasons I seldom do a simple V-Y pushback any more except in a modified form, after 5 years of age in conjunction with the insertion of an island flap for nasal lining lengthening in a short but mobile palate.
Cuthbert

Unobtrusive, quiet James Cuthbert came to plastic surgery as an orthopedic registrar during World War II. He joined Gillies at Rooksdown House, soon learned about pedicles and cut a lot of flaps for war wound defects, especially for the hand. After the war he was invited to Yugoslavia to establish a plastic surgery service there. Several days after I arrived to study with Gillies in 1948, a farewell party was given for Cuthbert, who was leaving for a new position in South Africa. Gillies, in an after-dinner speech, predicted that Cuthbert would take plastic surgery to Africa and “turn up all the giraffes’ noses.”

By 1951, James Cuthbert, then of the University of the Witwatersrand, Johannesburg, had designed a multiple transposition
of oral mucoperiosteal flaps to achieve greater posterior displace-
ment of the palate, minimize the risk of fistulae and avoid a
straight-line contracture along a two-layer closure. He designed
the main flap A which, when cut and peeled back, exposed the
posterior palatine vessels; these were then ligated and divided. A
shorter flap C was dissected and elevated, and the vessels were
divided. Flap B was left, based anteriorly, and it too was elevated
on the vessels coming through the incisive foramen. The nasal
mucosa was mobilized and divided transversely to allow posterior
displacement of the soft palate. Flap C moved back with the soft
palate, flap A was transposed at a 90-degree angle and flap B slid
toward the midline to close any anterior hard palate cleft.

When the cleft extended through the alveolus, an anterior
first-stage, Veau-type closure was achieved and the transposed
retropositioning carried out a few months later.

The lining layer on the nasal side was closed as well as possible.
Cuthbert rationalized:

If the transverse relaxing incisions leave a midline deficiency, this is of no
importance as long as it is placed to lie under the primary transposed flap A
which will prevent fistula formation.

Gillies was intrigued when Cuthbert’s method came out in the
British Journal of Plastic Surgery. By now I had returned to
England to write the book with Gillies and remember how im-
pressed I was with Sir Harold’s open-mindedness. He was always
willing to try a reasonable design even by one of his previous
students. He used the multiple transposition flaps on a few
palates but without dramatic results. We were all disturbed by
the large raw nasal area.

The last time I saw Cuthbert was during the 1959 Interna-
tional Congress in London. He, Barbara and I had been invited to
a delightful cold buffet by Lady Sam at the Gillies’ flat on Queen
Anne Street. After a few drinks and some fresh salmon from
Scotland, Sir Harold and Cuthbert had great fun pantomiming
the casting, hooking and reeling in of the great fish from the
waters of the South African shoreline. Five years later, after a
lengthy illness with severe residual pain, Cuthbert ended his life.
Thomas Gibson of Canniesburn Hospital, Glasgow, Scotland, had made several basic contributions to plastic surgery including the important treatise on the characteristics of cartilage. Then in 1959, 10 years before he became the respected editor of the *British Journal of Plastic Surgery*, he described a triangular flap for lengthening the short secondary palate which was similar to the Cuthbert principle. He reported no contracture of this flap with the nasal side raw, but combined the procedure with a Hynes pharyngoplasty.

He summarized that it was simple, was completed in one stage with a posterior displacement of 1.5 to 3.0 cm. and had no tendency to contract; any anterior holes could be closed with an obturator. In 1967 Hynes, after Gibson admitted using his pharyngoplasty, endorsed the Cuthbert-Gibson transposition flap for lengthening.

In 1976 Gibson wrote:

The transposition flap for lengthening the palate is an excellent operation with only one drawback. It is not always easy to avoid fistulas in the hard palate, particularly when the bony cleft is inadvertently exposed.
28. Pushback of Palate with Horseshoe-Shaped Incision

GEORGE Morris Dorrance of the University of Pennsylvania was a wealthy general surgeon who had inherited the Campbell Soup Company and became director of the Atlantic City branch of the Philadelphia and Reading Railroad. Among his hobbies was the improvement of the quality of tomatoes grown in New Jersey farmlands which supplied the soup canneries of his Camden plant. Once the Campbell Soup Company was sued by a woman who claimed to have opened a can of soup and found a bandaged amputated human finger. Dorrance's investigations revealed that no one in the company was missing a finger, and the suit was dismissed.

Dorrance, who did a lot of head and neck surgery, became interested in plastic surgery, particularly mandibular fractures and cleft palate. In fact, cleft palate became his surgical hobby. In April 1925, at the meeting of the Philadelphia Academy of Surgery, he outlined his "push-back operation" through a horseshoe-shaped incision for palatal lengthening, yet without entitling it "push-back":

The rationale is to displace the velum back to enable it to assist the superior constrictor muscle of the pharynx to close the nasopharynx during speech.

He justified his approach as compared to Veau's procedure thus:

Veau succeeds in getting satisfactory functional speech in his patients with cleft palate in the average case, without backward displacement of the palate. This, unquestionably, justifies his operation, except in cases in which there is a very marked shortening. Here, we must remember that Veau operates in France, and the majority of his patients speak French. The French language,
unlike the English, calls for more nasalizing sounds, and hence complete velopharyngeal closure is not always necessary. The functional results obtained by Veau are remarkable for individuals who speak French. However, turning to our patients who speak English and to individuals who talk German and Dutch, we find it imperative to perform a "push-back operation" in persons with cleft palate in whom the velum is usually short.

In 1933 in his exhaustive book, *The Operative Story of Cleft Palate*, certainly the palate classic of its time, Dorrance concluded:

From the patient's standpoint, any operation on the palate is judged by the speech result. The secret of obtaining good speech, in cleft palate patients, is to establish complete velopharyngeal closure. This can only be established by an operation which will lengthen the velum sufficiently to meet the pharyngeal wall and to permit the "palatopharyngeal-sphincter" to shut off the nasopharynx.

He was convinced that

Nearly all cleft palate patients have a short palate. . . . It is always necessary to displace the palate sufficiently backward to permit the "palatopharyngeal-sphincter" to function properly. . . . [Thus,] we have developed the "push-back operation."

Dorrance set the operation at 5 years of age because of less mortality and less chance of failure. In his first stage, he used the horseshoe-shaped incision with elevation of the mucoperiosteum from the bone back to the attachment of the palatal aponeurosis.
The posterior palatine arteries were divided, and the flap was replaced and sutured. If there was an inadequate blood supply to the palate, Dorrance left an anterior attachment over the incisive foramen as a precautionary delaying measure and dissected the mucoperiosteal flaps and divided the vascular bundles from the sides.

Three months later, in the second stage, the lateral incisions were extended backward around the maxillary tuberosity and over the pterygomandibular fold to obtain sufficient mesial displacement of the muscular tissue. The mucoperiosteal flap was reelevated down to where the nasal mucosa could be divided from its attachment to the posterior edge of the hard palate in a true pushback maneuver. The hamular processes were divided with a chisel, for Dorrance noted that the anatomical investigations of Wardill and Whillis were similar to his own. He too felt that

It is this palatal insertion of the superior constrictor muscle of the pharynx which completes the pharyngeal ring.

![Diagram](image)

A. Division of the hamulus on one side removes tension of tensor palati muscle in a case of cleft velum.

B. Division of hamulus on both sides removes tension of tensor palati muscles in a case with split velum and places palatal insertion of superior constrictor muscle in desired position to close nasopharynx.

On this basis Dorrance defended his sectioning of the hamulus, suggesting that it helped to restore the palatopharyngeal sphincter. Even after complete freeing of the mucoperiosteum from the bone, he pointed out, the tensor palati muscles hooking
around the hamular processes prevent palate retropositioning. Correction is achieved by sectioning and mesial displacement of the hamular processes, which then lengthens and converts the tensor muscle into a synergist with the levator palati muscle. He also noted:

This also displaces inward and backward that portion of the pterygopharyngeus which inserts into the hamulus thereby reducing the abnormally increased diameter of the nasopharynx which occurs in cleft palate.

Dorrance felt too that division of vessels was important and as late as 1946 insisted:

It is next to impossible to obtain the necessary length of the palate without cutting the posterior palatine vessels.

He believed that all these maneuvers achieved an effective posterior retropositioning of the palate. The edges of the cleft were then denuded, the intramuscular wire suture of Veau was
inserted with a Reverdin needle and the cleft was closed with a layer of sutures in the nasal mucosa and another in the oral mucosa.

Dorrance advocated use of his pushback in congenitally short palates and for reclaiming failures by other methods.

He diagramed the lengthening of the congenitally short palate by a horseshoe-shaped incision, elevation of the mucoperiosteum and release from the edge of the hard palate.

The dotted line shows the previous length of the short palate, but the length gained is not assured because of the large raw area on the nasal side.
Dorrance was one of the few cleft palate giants of the 30’s and 40’s whom I did not get to know. According to McDowell, he was indeed a giant, a very large man—tall, with broad shoulders, a large head, and large hands.

He died in 1949 while I was in England with Gillies. Because of his impressive book, a cleft palate bible which he left behind and which has been vital in helping to trace the evolution of cleft craft, I have inquired about him from several people who had the privilege of knowing or working with him.

The late Robert Ivy, then in his 90’s, came to Miami twice as visiting professor, and each time we would project portraits of various plastic surgeons no longer alive and urge him to reminisce. I flashed Dorrance several times, and although Ivy always gave a fair account, he would never wax eloquent, revealing the slightest suggestion of resentment. He noted:

Dorrance was not popular among the leaders because he was aggressive. He always spent lots of money on art, had diagrams of the palate operations but never a photographic record, not a picture.

Dorrance trained Arthur Dick of Washington, D.C., and must have towered over him. Dick recalled some interesting aspects of his teacher:

George Dorrance was a big man, over 6 feet and 200 pounds. He was domineering, demanding complete loyalty from his associates. Those who worked for him for years were necessarily quiet and docile like surgeon Bransfield and artist McNett. Having had contact with some of the "needlers" of plastic surgery, I can say from first-hand experience that Dorrance was a needler, a sort of minor-league Pete Moran! He was also a good technician. In spite of his large hands, he could get into a palate and complete a pushback in 20 to 25 minutes.

In Philadelphia in 1926 an important International Dental Congress was held in the convention hall, and such famous palate surgeons as Brophy, Gilmer, Ivy and Blair were there. Dorrance presented his pushback, and Limberg from Leningrad first presented his palatal lengthening procedure. Blair had an exhibit in the hall, and a young man named Brown, who had joined him just two years before, was in charge of it.
James Barrett Brown of St. Louis was one of the important forces who created the American Midwest mecca for cleft lip and palate surgery. Cases were referred from all parts of the country, and in 1936 Brown published his modification of the Dorrance pushback. In 1940 in *Surgery, Gynecology and Obstetrics*, with lovely illustrations by G. Hance, he described various ways of gaining extra length. He preserved the posterior palatine vessels, sectioning the tensor tendon in one stage. He left a small section of mucosa at the edge of the hard palate to which to suture the tip of his mucoperiosteal advancement flap. Brown kept it optional, depending on blood loss, as to whether or not the cleft in the palate should be closed during the lengthening or at a second stage. He reported 25 excellent results out of 32 patients. A large raw area was left on the nasal side, but, with so much pushback, some lengthening was achieved. If the cleft in the soft palate had not been closed during the first operation, it was quite easy to close it in the second stage.

In 1940 Brown described a double elongation in partial cleft palate where only a narrow band of bone and soft tissue is present anteriorly. He set the palate back once and then, by splitting the palatal mucoperiosteal flap, set it back on itself in a second pushback.

This much lengthening necessitated sacrifice of the arteries. The completed "double set-back" and closure of the cleft gained in length about the distance from the hard palate edge to the incisors and without any opening into the nose. The raw surface closed over in two to four weeks.
In reference to the denuded area of the anterior hard palate, Brown reported that complete healing occurred in 20 to 30 days and was practically normal in appearance except for the absence of rugae. He acknowledged a humping from side to side of the mucoperiosteal flap at the edge of the bone where the excess was folded on itself. He considered the actual lengthening to be the difference between the tissue in the humping and the distance the edge had been set back. Brown admitted:

A possible objection to this procedure is that the resulting raw nasal surface may contract and shorten the palate secondarily, but so far we have not noted this as being important enough to try to cover the raw surfaces with skin grafts. These palates usually appear excessively long on inspection and the surface nearly always smooths out.

Brown also used this principle of splitting the mucoperiosteal flap in complete clefts of the palate after the cleft closure had been accomplished in a previous procedure. Hance's drawings show the procedure clearly.
As already mentioned, St. Louis was a great cleft center during the 1940's, and many visitors from all over the world came to watch the Big Three B's, Blair, Brown and Byars. Then as now, visitors were prone to ask some unessential questions, such as "What kind of suture are you using?" This sort of thing used to send Barrett Brown up the wall! Edgerton recalled an incident that occurred while he was assisting Brown:

Dr. Brown had carried out one of his pushback operations on an incomplete cleft of the palate. He had closed the muscle layer and the nasal mucosa, and was in the process of putting in a row of interrupted sutures along the oral mucosa. As was his custom, he would rapidly run down 8 or 10 knots with each suture, to avoid having the patient's tongue successfully untie the suture in the post-operative period. A French surgeon who had been leaning over his shoulder all morning finally asked his first penetrating question of the morning:

"Dr. Brown, how many knots do you tie on each of those sutures?"
Barrett replied without hesitation:
"Seventeen."
and from that moment, by exact count, tied 17 knots on all of the remaining sutures.

It is possible that there is a surgeon somewhere in Europe today still throwing 17 knots on every palate suture in the hope of attaining a Brown result.

Controversy is the spice of life, and there was some "spice" between Brown and Dorrance. As assistant resident on Brown's and Byars' services at Barnes Hospital in St. Louis, I once asked the chief resident if a Dorrance pushback was to be used in a certain case. The loyal resident asked:

What is a Dorrance procedure?
Naively, I rose to the bait and told him in detail with dates. It was soon after this and several similar such slipups that Brown called me to his office and requested me to complete my last three months of required residency training somewhere else. I followed his suggestion, which turned out to be such a good one that I extended it to 18 months in Detroit and Houston.
There is always more than one side to every controversy, so I asked Josh Jurkiewicz what he remembered. He is a product of the Brown, Byars and McDowell school and is a smart, gentle but honest surgeon who cuts as deep as is required. He recalled in 1976:

About all I can remember was that Brown had little use for Dorrance or the Dorrance procedure. He felt that Dorrance was given credit for the pushback operation when, in fact, he should have been, i.e., Dorrance’s two-stage preliminary ligation of the descending palatine vessels was followed by the pushback and a skin graft to the palate, whereas Brown’s procedure was a straight-forward pushback. . . . Erle Peacock might have a story or two about Brown. He worked with Brown a great deal more than I did. I had a tendency to spend all of my time with Byars. Brown knew this and it annoyed him. Consequently, I was not one of his favorites.

Then I turned to one of the famous Missouri Four—Frank McDowell, who was there through most of it. In spite of his affection for Brown, he calls it as he saw it and possibly sheds some light on Ivy’s reluctance to reminisce on Dorrance:

Blair and Brown were good friends of Dorrance and good friends of Ivy, but there were some local frictions between Dorrance and Ivy—precipitated probably by the situation whereby Ivy was Chief of Plastic Surgery in the School of Medicine of the University of Pennsylvania, whereas Dorrance could not get an appointment in that school and had to be satisfied with being Chief of Maxillo-Facial Surgery in the School of Dentistry of the University of Pennsylvania. This was particularly abrasive to him because it was Ivy who had a dental degree, not Dorrance—whose background was in general surgery and who did a lot of big head and neck cancer surgery at the American Oncologic Hospital in Philadelphia. The whole business was the height of irony. Dorrance probably could not escape the feeling that if Ivy had tried harder, he could get Dorrance a position on the medical faculty; Ivy, on the other hand, told me that he did try hard, but the general surgeons who were in control of the Department of Surgery in the medical school didn’t want Dorrance because they viewed him as a threat to some of the head and neck cancer work they wanted to do. Dorrance’s first paper on his pushback was published in 1925 in *Annals of Surgery*. He thought he would have to make the mucoperiosteum of the hard palate a delayed flap to keep it from sloughing, so he did a preliminary operation to raise this area and to cut both palatine arteries and tie them off. He also thought that it was difficult to raise the palatine flaps satisfactorily without tearing the
arteries, and if this was successful, the intact arteries would inhibit the retrodisplacement of the palate.

Brown devised a technique for "stretching" the arteries out of their foramina and elongating them while raising the palate, and then for cutting them loose from the palate flap for one or two cm. forward from the bony foramina—so that he had more than enough length to the arteries to set the palate back as far as it would go, with the arteries which were formerly running in an anterior direction now running in a posterior direction part of the way. He thought the advantages to this were: (1) it required one operation instead of two, and (2) if the palate were raised only once and set back at the same time, there would be less scarring in the anterior part of the soft palate than if it were raised twice.

Dorrance was at first a little resistant to this, and he had some feeling that Brown's calling his operation an "elongation" or "setback" implied that the whole concept was a new one. However, Brown explained to him that he used the new words so that the delayed flap would continue to be known as a "pushback" and the direct flap would be known as an "elongation" or "setback." Rather than insisting that Dorrance was wrong, he wanted to present his operation as an alternative for those who thought they had the technical skill to do it.

Dorrance came out to St. Louis and watched Barrett and watched me do this procedure several times. He came to believe in it and (about 1940) he told me at the operating table, "If I were your age and had your hands, this is the way I would do it."

In our experience, the procedure worked much better for partially cleft palates than for complete clefts—and it worked much better when it was done at the same time the partial cleft palate was closed (preferably around the age of 18 months). When the combined procedure was done at this age, it was almost unheard of for the child to require any speech training whatsoever, or to have anything other than the spontaneous development of perfect speech. Sometimes, there was some scar pull medially on the canine or bicuspid teeth, usually resulting in the medial displacement of one or two teeth from the arch—rather than contracture of the whole arch, which also occurred on rare occasions. We did not see retrusion of the upper jaw in these patients.

In his 1958 book, *Reconstructive and Reparative Surgery*, Hans May had Dorrance's great artist McNett sketch Brown's setback modification of the pushback with preservation of the vessels and secondary cleft closure, which was an interesting switch in itself. The drawings were so superb that they have been included for extra clarity.
GRAFTING NASAL RAW AREA

Eventually the raw nasal side of the pushback began to get attention and then coverage. In 1942 Hamilton Baxter of Montreal began to apply split-skin grafts to the raw surface. In 1943 George Dorrance and John Bransfield of Philadelphia were also covering the nasal raw area in their pushback operation with skin grafts as shown!

A USEFUL PRINCIPLE

The horseshoe-shaped incision incorporates all anterior mucoperiosteum in one unit for a pushback in a most efficient manner. Of course it is only available in incomplete palate clefts or sometime after anterior closure of complete palate clefts. I favor the method quite often and, as will be described later, like to take a bipedicle island flap off the anterior portion of it to line the nasal defect of the pushback.

TOGGLE TACKING

When mucoperiosteal flaps have been elevated during palate surgery, especially in the horseshoe flap of Dorrance, the surgeon often has difficulty reattaching these flaps to the bare bone to prevent them from flopping about. This can be quite a "sticky" problem.

In 1976, in the British Journal of Plastic Surgery, Dave Furnas, with Myron Bloom of the University of California, Irvine, exer-
cising the ingenuity of the human fly clinging to a wall, described a clever way to fix palate flaps to the inscrutable flat surface of the denuded hard palate. A single hole is drilled through the bone. A small rectangle of Teflon, 1.5 × 5 mm., is cut from (John Dore Co.) 0.38 mm. sheeting. A suture is passed through the flap, through the Teflon crosspiece and back through the flap. The toggle is inserted through the hole and locked, and the suture is tied. Two toggle ties are shown in the diagrams. If greater strength is needed, the toggle can be made of stainless steel or titanium. Furnas noted:

This toggle is particularly useful in cleft palate surgery; a Dorrance or Veau flap can be secured to bone as readily as a Wardill or a Langenbeck, and dead space is eliminated.

He added later:

This is a homely little contribution, but it does give the surgeon endless flexibility in cutting and positioning the palatal flaps, in that anchoring points can be completely disregarded. The Teflon toggle can secure the soft tissues to any point on the bone.
29. Methods of Handling the Neurovascular Bundles

The fixed position of the neurovascular bundles coming out of their bony foramen has always had a restraining effect against successful pushback procedures.

Blunt Freeing and Tugging

Timid and gentle surgeons have been content to tease the bundles free or pull them gently from their bony exits, achieving an apparent stretch but probably with an ineffective gain. MacCollum at Boston Children’s Hospital about 1944 used to describe this maneuver “like a robin pulling an earthworm out of its hole.” Yules used the same description 30 years later.

Osteotomy

Alexander Limberg of Leningrad evaluated the costs and, deciding that bone was more expendable than blood supply, proceeded to plan resection of the posterior wall of the foramen. In his paper “Neue Wege in der radikalen Uranoplastik” in 1927, he stated:

The artery palatine major should be freed together with the periosseum circumferentially. Then follows the “Resectio margina foramines palatini,”—the posterior and medial edge is resected by a chisel. The neurovascular bundle can now be easily moved from the canal posteriorly and medially.
Herbert Conway of Cornell University Medical Center expressed his preference for Limberg’s osteotomy in 1947.

Since preservation of the blood supply and the innervation of the soft palate are in keeping with the principles of reconstructive surgery, the thought occurred that the freeing of the neurovascular bundle from its bony environment would overcome the objection offered to Brown’s technique for push-back operation and yet allow for the effective performance of the procedure in one stage. The osteotomy is performed with a small chisel... a thin plate of bone, 3 to 4 mm. in width and 1 to 1.5 cm. in vertical dimension, is removed—after the osteotomy is completed, the palate is dislocated posteriorly so that the palate touches the posterior pharyngeal wall.

In 1962 Ohmori of Tokyo noted:

Doctor Tange, one of our co-workers, devised a special chisel for the operation of cleft palate with which the bone surrounding the major palatine artery is cut off.

In 1964 R. Ruding of the Netherlands observed that during palate closure

The greater palatine artery should also be displaced backwards, especially because the greater palatine foramen is relatively forward from its normal position in the case of cleft palate. If not displaced posteriorly, the neurovascular pedicle will tend to keep the muscular mechanism forward, and this in turn will lead to reattachment of the muscle in its original position. Veau states that it is possible to pull the artery from the palatine canal but I find this quite impossible... The posterior rim of the foramen is quite angular, and during a push-back of the tensor-levator system the artery will ride over the sharp edge. Because the vessel may be unnecessarily pinched or kinked as it rides over the rim, it is useful and easy simply to chisel away a portion of the back wall of the greater palatine foramen.

Although the Limberg osteotomy became popular, was used by many surgeons and is used in some clinics today, there were some surgeons who objected. Stefan Demjen, who favored dividing the vessels, argued:

I always have objected to using chisel and hammer for “retrodisplacement” of the bundles for two reasons: (1) osteotomy is a traumatizing procedure, (2) the retrodisplacement gained in this way can be effective only if it is done extensively, which is an unpredictable procedure and can do more harm than help.

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DIVISION OF THE BUNDLES

The more radical surgeons actually divided the neurovascular bundles on purpose. As noted by McDowell, George Dorrance advocated cutting the major arteries; it had always been his contention that in a correctly performed von Langenbeck operation the posterior arteries were divided. He was not concerned that his procedure did the same and defended his stand in 1925:

Does not this method predispose to sloughing of the flaps? In the cases I have observed so far, I have noted less blanching of the flaps than in my usual cleft palate operations. There has been no sloughing. The blood supply comes in through the tonsillar plexus.

Yet in later papers Dorrance advocated a preliminary operation to cut and tie the arteries while raising the flap, considering it safer to delay the flap.

Other surgeons, like Axhausen, Wardill, Browne, Hynes, Cuthbert and Demjen, also were determined to sever this tether and achieve their objective at all cost. With or without a delay, they simply ligated and divided or cut and twisted the vascular bundles. The soft palate was thus definitely freed from its moorings to the hard palate and allowed to drift back toward the pharynx.

As early as 1933 Wardill wrote his thoughts on the division of the posterior palatine artery during palate surgery.

A great deal has been written about the necessity of preserving this vessel, and while I would not advocate its division as a routine procedure, on the occasion when I have done this by accident or design I have seen no ill results following. Sometimes it is essential to divide both vessels so as to bring the two halves of the palate together without tension.

A rare combination of Hughlett Morris of the University of Iowa and Stefan Demjen of Comenius University, Bratislava, in a 1978 book, *The Bratislava Project*, described and evaluated Demjen's modification of the W-V-Y palate pushback in which he ligates the posterior palatine vessels. Morris concluded:

The studies in the Bratislava Project which relate to general maxillofacial growth and development indicate that severance of the neurovascular bundle is not greatly detrimental to the growth and development of the midface.

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THE COST

In 1959 Broadbent and Hochstrasser studied mongrel puppies after division of the descending palatine nerves and found no gross or microscopic atrophy of mucous glands or muscle tissue and no paralysis. In two human cleft palate cases, however, they sectioned the left neurovascular bundle and found that the half of the palate on the sectioned side was 3.0 to 3.5 mm. shorter than that on the control side with a reduction in palatal bulk. Secretory activity of the mucous glands on the sectioned side many months later was approximately one-fourth that of the normal side. These findings confirmed an obvious dictum: Unnecessary division of the neurovascular bundle is contraindicated. In fact, the authors went even farther:

Section of this neurovascular pedicle is not permissible in palate repair in humans without fear of atrophic shrinkage.

DISSECTION OF THE NEUROVASCULAR BUNDLE OFF THE FLAP

As early as 1940 James Barrett Brown of St. Louis had found a way to preserve the vessels but achieve lengthening without sectioning the posterior foramen wall:

Preservation of the major palatine arteries is possible in nearly all patients, and freeing is effected by careful loosening of all tissues around the artery, gently stretching it from the foramen and, if necessary, cutting it away from the palate flap. These methods have seemed better than trying to dislodge the artery from its bony canal by trying to remove the posterior wall of the canal.

Frank McDowell, with M. Fryer and J. B. Brown, described the procedure in greater detail in 1954:

The arteries are stretched out of the bony canals and partially loosened from the palate flap, but are left intact. If there is any question as to the length of the arteries, they should be carefully freed from the palate flap for a distance of 1 to 1.5 cm. forward before the elongation is done. They must be loose enough to completely change directions and even run backward a little ways after the palate is set back.
Peter Randall recalls teaching residents to dissect the vessels off the mucoperiosteal flap in 1954 at Barnes Hospital.

**SHARP DISSECTION OF VESSELS**

Milton T. Edgerton, a soft-spoken Georgian with the ecclesiastical presence of a clergyman, inherited the position of chief of plastic surgery at Johns Hopkins Hospital after the death of Edward Hanrahan. In 1961 Edgerton first gave his old teacher credit for the general idea of freeing the neurovascular bundles:

J. B. Brown in 1936 made an important addition to the surgery of partial clefts by “mobilizing, but not cutting, the major palatine arteries from their foramina.” He was able to get the vessels in all instances to stretch or elongate sufficiently for the palate to touch the posterior pharyngeal wall at the end of the operation.

In 1962 in *Plastic and Reconstructive Surgery* Edgerton mentioned his own occasional unhappy experience with a “blunt” approach, attributing it to the limited length of the neurovascular bundles. He then reported his series of 50 cases in which he had freed the neurovascular bundles extensively by sharp dissection from the mucoperiosteal flaps. He noted interesting anatomical findings:

The three descending palatine nerves course forward closely parallel to the major palatine artery and ... by the division of two tiny minor palatine
arteries near the greater palatine foramen, the major palatine artery and descending palatine nerves can then be dissected free from the palatal mucoperiosteal flap for a distance of some 2 cm. anteriorly without encountering other major branches. It may be seen that for every centimeter that one dissects the neurovascular bundle free from the palate flap, he gains approximately 2 cm. in posterior mobility of the palate flap... The technique is of value, both in repair of complete and partial clefts of the palate.

In 1976 Edgerton wrote me:

Sharp dissection of the neurovascular bundles may be the most important contribution that I have made to this complex subject. That simple device, for the first time, made it possible for me to place the mucoperiosteal flaps at any point I wished, in the process of retropositioning the palate.

Demjen enumerated Edgerton’s 1962 reasons for preserving the major palatine arteries during lengthening procedures:

1. The actual circulatory safety of the palatal flaps during the healing period, 2. the later bulk and secretory activity of the palatal mucous glands, 3. the actual length of the soft palate, 4. sensation and taste in the repaired palate, and 5. subsequent growth of the underlying bones

and then proceeded to attack Edgerton’s claim with:

These statements are in contradiction with my personal experience and clinical observations.

**IF IN DOUBT, DON’T, OR SAVE THE VESSELS**

Although the neurovascular bundles do tend to tether the soft palate to the hard palate, there seems to be no real justification for dividing them. It is not likely that their division will be catastrophic for either blood supply or growth. Yet if they can be freed from the foramen or the flap, and if necessary the restricting posterior wall of the foramen can be removed, there is no need to divide them. It takes a little more time and skill, but these vessels can be of great value under certain circumstances. If they have been destroyed at leisure, they are alas no longer available for important duty in an emergency!
30. The Nasal Defect After Pushback

One century ago the American Indian was undergoing "operation pushback" on the frontier of the New World, while in Europe the palate also began to be subjected to "pushback" operations. As Newton noted, for every action there is an equal and opposite reaction: The Indians resisted the push with tomahawks and flaming arrows, while raw areas of pushed-back palates granulated and contracted.

On June 25, 1876, Chief Crazy Horse and his bands of Sioux and Cheyenne warriors wiped out General Custer and his men at the bloody battle of Little Big Horn. Meanwhile, in Paris from 1876 to 1878, Passavant, experimenting with various pushback palate procedures, became discouraged by contracture as did others who followed him. Not until over half a century later and many a "last stand" in palate pushback did surgeons begin to develop a defense against the "Little Big" nasal raw area.

As surgeons became more dedicated to lengthening the soft palate toward the posterior pharyngeal wall, the number of pushback procedures increased. Surgeons like Dorrance, Brown, McDowell and Byars were radical enough and divided the nasal mucosa from the posterior edge of the hard palate, increasing the immediate effective pushback lengthening. This left the nasal side raw for the exact amount of pushback, and gradually the length obtained at operation diminished.

In 1952 Wallace Steffensen reviewed the palatal lengthening operations and expressed a feeling that more accurate records of
Randell Champion of Manchester, England, noted in 1957:

In the standard V-Y closure of a cleft palate the palatal mucous membrane of the soft palate is lengthened by reflecting the mucous membrane from the hard palate and then suturing the hard palate mucous membrane in a more posterior position, incorporating some of it in the soft palate. The nasal mucous membrane is reflected from the medial and posterior edge of the hard palate but is not lengthened or transposed backwards. . . . Thus with healing the palat mucous membrane tends to return to its original position because there is no corresponding lengthening of the nasal membrane to maintain the lengthened velum.

In 1960 James Calnan of London observed that after certain V-Y retropositioning operations there was failure to obtain the expected length. He offered the presence of midline fistulae at the posterior border of the hard palate as evidence of breakdown and fibrosis with contracture of the soft palate. Even in the absence of a fistula, he presumed a hidden breakdown and scarring of the nasal mucosa with resultant contracture. Thus, as the evidence mounted, more surgeons were stimulated toward more sophisticated efforts of coverage of this nasal area.

Z-PLASTY

A standard lengthening procedure, of course, is the Z-plasty, and some surgeons have advocated this principle for lengthening the nasal lining. In 1957 Champion wrote in the *British Journal of Plastic Surgery*:

The nasal membrane may be lengthened by undertaking a Z-plasty of the nasal mucous membrane. This small plastic manoeuvre is of utmost importance in the primary repair of a cleft palate and may make the difference between normal and imperfect speech. The Z-plasty also tends to reduce the palatopharyngeal opening. In a small percentage of primary repairs it is not possible to perform the Z-plasty, particularly in clefts involving most of the hard palate. . . . In secondary repair of palate the creation of a large Z-plasty or two smaller Z-plasties may materially influence the final result.

In 1962 in *Plastic and Reconstructive Surgery* Edgerton advocated palatal lengthening with sharp dissection of the neurovas-
cular bundles. This resulted in a shortness in the nasal mucosal lining. He chose the Z-plasty principle for lengthening the nasal mucosa.

As the presence of a cleft in the palate usually indicates lack of tissue in the transverse dimension, it is a contradiction in logic to expect to get anterior-posterior lengthening with a Z at the expense of side-to-side tightening.

**SPLIT-SKIN GRAFT**

**Baxter**

Hamilton Baxter, a Canadian surgeon in Montreal, had also become pessimistic about the fate of the nasal raw area after palate pushback. He had the plastic sophistication to extend the principle of “cover to all raw area” to the superior, “out of sight” surface of the palate. In 1942 in the *Canadian Medical Association Journal* “Happy” Baxter proclaimed the not-so-happy fact that the von Langenbeck procedure not infrequently failed to achieve normal speech and gave his explanation:

This is due to the anterior pull of the contracting scar tissue on the nasal side of the mucoperiosteal flaps so that the velum cannot be brought into contact with the velopharyngeal wall, and speech assumes “cleft palate” characteristics.

In the severely shortened palate, where all the length achieved by a pushback was essential for good speech, Baxter devised a method, in 1942, which he said would
avoid the thickening and shortening which an unlined flap with its raw surface exposed will always undergo, irrespective of its situation in the body.

Inspired by Gillies’ application of Esser’s principle of a skin graft on a stent to the raw bony surface in the Gillies-Fry pushback, Baxter made two lateral incisions in the mucoperiosteum a few millimeters from the teeth, extending from the tuberosity of the maxillae forward to the canines. The posterior palatine vessels were divided, and the mucoperiosteum between these incisions was elevated. For this tunnel a piece of red wax was fitted, covered with a thick split-skin graft from the hairless buttocks and then inserted as an inlay. The incisions were sutured and left for one month. Finally, the stent was removed and the anterior release completed with a Dorrance incision, allowing a radical pushback of the palate. The nasal surface of the mucoperiosteum, having been lined with skin, was expected to show little or no tendency to contract and foreshorten the elongated palate.

Five years later in 1947, and four years after Dorrance and Bransfield published their method of applying skin grafts to line the raw nasal surface of mucoperiosteal flaps for pushback in seven types of palate defects, Hamilton Baxter and Mary Cardoso of McGill University and Children’s Memorial Hospital, Montreal, noted:

Since many surgeons working independently have sometimes reported new methods co-incidentally, no one man can lay complete claim to an operative procedure, since tribute must be paid to the experiences of preceding and contemporary surgeons whose efforts have provided the foundation on which some technical refinement is based.
They then reendorsed their skin graft method in *Plastic and Reconstructive Surgery* and used these diagrams to show bilateral skin grafts for lining the future nasal surface after pushback in clefts extending through the hard palate, similar to that described by Dorrance and Bransfield in 1943.

Subsequently the lined flaps were elevated, the cleft was closed and the palate was pushed back. When the palate was short and contracted after primary closure, the mucoperiosteum was elevated by splitting it to avoid opening the cleft. A stent wrapped with a skin graft was buried under the flap, and later a pushback of the lined flap left a skin graft also covering the bone.

They reported speech results better than those following the ordinary operative procedures. They also noted:

In all cases examined by nasopharyngoscope, the graft was found to be viable and with no evidence of crusting or offensive odor. Grafts over a year old had developed a pinkish color and one graft which was five years old had evidently undergone considerable metaplasia, for only a faint whitish tinge differentiated the graft from the surrounding mucosa.

**Dorrance also using skin grafts**

Obviously, Dorrance too had become concerned about the raw area on the nasal side of the lengthened portion of his palates. In 1943, with John Bransfield, he described a modification of his two-stage pushback which applied skin grafts to this area. They designed its use in seven types of cleft defects and published their work in the *Annals of Surgery*. In the first stage the mucoperios-
teal flap was elevated, a split-skin graft applied to the undersurface and the lined flap replaced in its original position. In the second stage the "push-back" procedure was carried out as previ-

ouslly described, but the sliding portion of the mucoperiosteal flap now was lined with skin grafts, which ensured maintenance of the acquired length by reducing contracture. The cleft in the velum was closed at this time.

In 1955 R. Ruding of Amsterdam presented his release of the nasal mucosa and closure with a Thiersch split-skin graft. In 1977 he wrote:

Later on, I saw that the skin transplantation was not necessary and abandoned it for muscle correction, described in 1964.
Brown holds his nose

Barrett Brown’s eventual response to this nasal skin graft was not without a nasal grimace. He explained that skin grafts on the nasal surface of the palate pool mucous discharge, resulting in desquamation of epithelium and producing a foul odor. As he gladly applied split skin by the yard almost everywhere else on the body, it is noteworthy that he was adamantly against it for surfacing the nasal raw area in palate pushback procedures. Thus any popularity enjoyed by this approach was soon snuffed out.

FREE GRAFTS OF MUCOSA

In 1949 Richard C. Webster of Brookline, Massachusetts, commented that skin grafts in palatal lengthening were becoming more and more popular in spite of the reports of contracture and crust formation. He also said:

In addition, there is the possibility that hair will grow on a certain number of these grafts; and hair on the nasal side of the soft palate would be disagreeable, to say the least.

Webster reported his use of free mucosal grafts to line the nasal side of the pushback:

Following a discussion with Dr. Bradford Cannon, the reviewer [Webster] has used mucous membrane grafts applied to the nasal side of the mucoperiosteal flaps. The mucous membrane grafts were taken from the buccal mucosa and applied in the first stage of a two-stage "push-back" procedure. In the second stage, the flaps were elevated and the palatal tissues retrodisplaced. There has been no evidence of crust formation where these free transplants of buccal mucosa were made.

Victor Spina, with Lodovici, Pigossi and Faiwichow of São Paulo, Brazil, in 1961 in Revista Latino-Americana de Cirurgia Plástica, suggested a one-stage pushback procedure using a free graft of buccal mucosa—Cardoso’s method—to cover the open wound on the nasal area of the elongation. Yet the difficulty of obtaining such a graft, the irregularities of the base, the inaccessibility of the area for dressings and the hazards of an unseen "take" and survival have been responsible for little acceptance of this approach.
SLIDING NASAL MUCOSA

Thomas D. Cronin of Baylor University College of Medicine, Houston, is quiet, mild and most unlike a textbook Texan. In 1971 he reaffirmed Dorrance’s 1933 and 1943 dogmatic declarations:

Most cleft palates are also short palates, and repair of the cleft alone is likely to leave the patient with an incompetent velopharyngeal mechanism. Retrodisplacement of the soft palate is one of the more obvious remedies, but to achieve this posterior movement it is necessary to sever the nasal mucosa from the bony palate. When the velum is shifted back, however, a raw area is left on the nasal side of the mucoperiosteal flaps. While an effective lengthening can be obtained at the operating table, the scar contracture of the healing raw area on the nasal surface pulls the velum back almost to its original position.

In 1957 Cronin proposed posterior advancement of mucosal flaps from the nasal floor to shift the raw area to a bony surface and reduce the soft tissue contracture. Fourteen years later, he stated:

This operation is recommended as the primary repair in all infants and young children. It may also be used in young children who have a short palate following a simple closure of the cleft. In older children and adults the procedure usually should be combined with a pharyngeal flap or nasopharyngeal implant.

Cronin cautioned:

In order to minimize the adverse effects of scar contracture secondary to elevation of mucoperiosteal flaps on bone growth, the pushback procedure should not be performed before 2 years of age in unilateral clefts of the primary and secondary palates, or in clefts limited to the secondary palate. Repair of complete bilateral clefts should be delayed until the age of 2½ years.

Operative details

The Ganzer-type mucoperiosteal flaps are elevated and Limberg’s ostectomy is used to free the neurovascular bundles. Then Cronin gets out his bag of new short irons. First, his right-angle knife is inserted through each nostril and passed backward until seen at the posterior edge of the hard palate in the cleft. The instrument
is then withdrawn 1.5 cm., and the blade is moved transversely from side to side several times across the rather irregular floor of the nose. Then the Freer knife is passed through the nostrils and is used to cut the mucosa on the lateral and medial boundaries of the nasal floor.

In incomplete clefts, this action is entirely blind; in complete clefts where access is possible a right-angle scissor may help in the transverse cut of the nasal mucosa.

Now, and not until now, the aponeurosis is detached from the posterior border of the bony palate with a Freer septal elevator, being careful not to tear the thin nasal mucosa.

Further nasal mucosal freeing and release will eventually allow the palate to move backward, dragging its thin mucosal flaps with
it like a bridal train. Hamular fracture is used when indicated. Suture of all flaps to one another and apposition of the oral mucoperiosteal flaps with iodoform packing under guy wires passed through the gums complete the operative procedure.

This was Cronin’s 1957 design for closing and retropositioning the soft palate at one operation in a narrow single cleft. (A) The broken lines showed the mucosal sulcus flap, an anterior triangular mucoperiosteal flap and two remaining asymmetrical mucoperiosteal flaps. The dotted line marked the division of the soft palate attachments to the hard palate. (B) The vomer flap was turned under the anterior triangular flap and the mucosal flap from the sulcus gave oral closure in the alveolar area. (C) The nasal mucosa had been shifted to cover the advancing mucoperiosteal flaps. (D) The longer mucoperiosteal flap was shifted toward the cleft side to avoid two superimposed suture lines.
Pre-pushback marking

The posterior bony edge of the hard palate and the point in the nasal mucosa detached from this edge are marked with 28-gauge wire knots to measure the actual lengthening achieved at one week and at two months after pushback. A single lateral x-ray view was taken with the central rays directed 1 inch anterior to and 1 inch below the external auditory meatus.

Postoperative measurements

In 1965 Ray Brauer, Cronin's Texas "pardner" for over 20 years, reported on the x-ray examination of 85 patients, 10 of whom had lost their wires before completion of the study. Of the 75 remaining patients, 46 percent revealed a contracture of 1 mm. or less and 37 percent a contracture of 2 to 3 mm. Seventeen percent showed 4 mm. or more of contracture, and of these cases six were posterior clefts (blindest type)—three horseshoe clefts and three wide clefts through half the hard palate. As pointed out by Brauer:

The extremely wide clefts, especially the posterior and the horse-shoe type, coupled with inadequate nasal flaps, are the major factors resulting in excessive contracture.

Here is Cronin's diagramatic sketch published in Plastic and Reconstructive Surgery in 1957, displaying the complex shifting of nasal mucosa in a wide, horseshoe-shaped defect. A flaps swing in together, B flaps swing back, leaving an area (C) still raw on the nasal side.

However, it was possible to claim

an overall average for all cases of 12 mm. with a contraction average of 2 mm. or an overall gain of 10 mm.

This approach has its ardent followers because it is logical and reasonably sound in principle. For instance, in 1970 Manchester described his modification of the Cronin nasal advancement principle along with a V-Y retropositioning of the oral mucoperiosteum in his second stage of complete bilateral clefts.
Yet it is technically difficult, because it calls upon **blind** and **bloody** dissection of **thin** mucosa, requiring a whole new bag of clubs. Its only physiological "drawback" is the denudation of **both** sides of the bony palate.

When needled about such plastic acrobatics, Cronin responded:

All of the residents and preceptees in our plastic surgery training program in Houston have learned to raise the nasal flaps successfully.

Whereupon Herb Conway, with typical Irish wit, retaliated:

But I would have to go back through a residency, and even then I doubt if I could ever do it!

Moore and Chong of East Grinstead, England, stated in 1967:

Cronin (1957) advocated the use of flaps of mucosa from the floor of the nose to cover the raw areas of the lengthened soft palate, the flaps being raised by a special knife introduced through each nostril. The technique, though in theory sound, was in practice difficult and did not gain universal approval.

**NASAL MUCOSA TRANSPOSITION**

David B. Stark of the State University of New York, Syracuse, in 1963 described a variation in the use of nasal mucosa. Accompanying the standard Wardill-Kilner V-Y oral flap design, he utilized the nasal mucosa to achieve lengthening with closure in a staggered line. He freed the nasal mucosa of one palate shelf, and with its base posterolateral transposed it into the usual transverse releasing incision in the nasal mucosa, along the posterior edge of the hard palate. This is the nasal rendition of the transposition lengthening that Cuthbert described in oral mucoperiosteal lengthening.

In 1976 Stark confirmed his continued use of the nasal flap:

It is the simplest, of course, to do in the partial cleft where the procedure is really a proper Z-plasty.

In the complete cleft, I do the anterior palate defect repair with a vomer flap and a labial flap between the alveolar ridge defect to prevent a pre-alveolar fistula. The second stage repair done about two months later will be
determined by the position of fixation of the vomer to the uncial side palatal shelf. Frequently the repair will be anteriorly with a vomer flap brought across and posteriorly with the nasal lining flap based on the posterolateral area of the cleft side. In most instances this allows for complete closure of the nasal surface and for as much retrodisplacement as you wish.

Actually, my problem has been a deficient length of oral mucoperiosteum if the setback is allowed to be as great as can be produced by the nasal lining. In other words, the restriction of retrodisplacement is due more to lack of length of the Wardill type of oral mucoperiosteal flaps than to a problem of getting coverage on the nasal surface of the lining flap.

This method seems to suffer some of the problems of the Cronin approach. It requires blind dissection and may offer limited lengthening, but it certainly denudes both sides of the hard palate of its covering mucosa and mucoperiosteum.

A TURNOVER FLAP FOR HARD PALATE NOTCHES

A mucoperiosteal flap based posteriorly on the edge of the cleft to be turned backward to present mucosa for the nasal lining in the cleft is based on the Krimer principle and was used on a large scale by Bonfils in 1830. Over 130 years later, Edgerton reduced this same flap to fill notches in the hard palate only, as shown in his illustrator’s drawings presented in Plastic and Reconstructive Surgery, 1962.

The concept appealed to me, but in actual practice, in my experience, the flap has a poor blood supply and does not remain
viable. It is interesting that the drawings for Edgerton, by their realistic shading, forecast doom for this little flap by leaving it white, just as I have seen it at the end of an operation. The point being made here is: Beware of flaps on the palate meridian, particularly at the attenuated edge of the cleft.

**VOMER FLAPS**

Charles Horton of Norfolk is extremely adept at many things, and one of them is maneuvering mucosa into areas of need. In 1973 in *Plastic and Reconstructive Surgery*, with T. Irish, J. Adamson and R. Mladick, he described the use of vomerine mucoperiosteum to be turned as two long narrow flaps based posteriorly and sutured into the transverse nasal mucosal defect created by the division of the soft from the hard palate in a pushback.
Horton wrote to me in 1976:

I have used this approach several times over the past few years but it requires a particular kind of case with a large vomer and one in which vomerine tissue is not needed elsewhere.

In the 1978 *Cleft Palate Journal* Harold D. Clavin and John Q. Owsley, Jr., of the University of California, San Francisco, presented a posteriorly based vomer mucoperiosteal flap (B) on the cleft side and a nasal floor mucoperiosteal flap (D) (Cronin) on the non-cleft side to supply nasal lining during palatal pushback in unilateral clefts. This combination seems to have some promise. Of course, the disadvantage is the same as with all methods elevating large areas of mucoperiosteum and leaving raw areas: the possible effect of maxillary growth retardation in children below the age of 5 years.

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**Forked Flap from Tail of Vomer**

It is possible to utilize the vomerine mucosa for nasal closure of the hard palate in the usual manner and still incorporate posterior extension flaps, shaped like a forked flap, to be transposed bilaterally into velar nasal lining releasing incisions. This maneuver will supply some extra lining for lengthening, without the need for elevation or sacrifice of hard palate mucoperiosteum. It can be
done early and in the primary operation, especially in a bilateral cleft of a short palate where an island flap may never be available.

In 1979 this approach was used in a 3-year-old bilateral cleft of the lip and palate. A midline mucoperiosteal incision along the vomer was extended off the posterior end, circumscribing two posterolateral (forked) flaps (X and Y). This allowed dissection of the usual vomerine flaps which were sutured to the nasal mucosa of the lateral cleft edges of the hard palate. The levator muscle attachments were freed from the hard palate edge and the nasal mucosa divided along the posterior bony border with a release of 0.75 cm. Into these nasal lining defects the forked flaps were sutured and the oral mucoperiosteal closure achieved with von Langenbeck flaps and mattress sutures.

**Regenerated vomer flap**

Bengt Johanson of Göteborg, combining the principles of "Never throw anything away" and "Get something for nothing," emphasized to me his use of the epithelialized granulation area across the anterior cleft as a flap, no less, to provide some midline lining on the nasal side. It could not, of course, be used to fill a nasal pushback defect.

Personally, I would consider this flap a possibility but also a bit unpredictable since it is hidden on the nasal side where its fate is not easily known.
TRANPOSITION OF LATERAL PHARYNGEAL FLAPS

The feisty F. T. Moore of Queen Victoria Hospital, East Grinstead, England, designed a secondary procedure which transposed the Hynes-type flaps for nasal lining of the velum (British Journal of Surgery, 1960). This obliterated the lateral recesses of the nasopharynx, lengthened the soft palate and produced a mass of tissue on the upper surface of the soft palate to facilitate contact with the pharyngeal wall, and augmented the elevation of the soft palate by a contractile muscular sling. He split the soft palate in the midline to facilitate the cutting of two thick mucosal flaps, one from each posterior pillar with the base above. A transverse mucosal releasing incision was then made on the superior nasal surface of the soft palate, about halfway between the uvula and the hard palate edge. The two flaps were transposed 90 degrees, as in a Hynes, but let in on top, across the soft palate, instead of across the posterior pharyngeal wall.

Moore reported that out of 15 cases of rhinolalia from various causes such as cleft palate, congenital short palate and suprabulbar agenesis, normal speech had developed in 12 in three months, with three requiring three to six months of speech therapy.

Sullivan

With results like these, it is amazing that more surgeons did not drop what they were doing to follow the same approach. Perhaps the illustrations required too much concentration and imagina-
tion to decipher the game plan. Fortunately, David Sullivan of Spokane personally observed the deft Jerry Moore demonstrating his bilateral pharyngoplasty in 1959. In 1961 Sullivan endorsed the method and reported on 13 cases with rhinolalia in which he obtained normal speech in six but improvement in all.

A 10-year follow-up report in 1971 by Sullivan corrected the title of the procedure to “Bilateral Pharyngeal Wall Flaps to Soft Palate.” He reported 26 additional cases, two of which were overcorrected, resulting in denasality and requiring partial reopening of the constricted nasopharynx. Moreover, since many of his failures occurred in patients 15 years and older, he preferred to operate at 5 to 10 years, and the earlier in that range the better.

In 1972 Sullivan wrote me more about his experience with this procedure, which he suggested might be entitled “The Irish Connection”:

As I have attained experience with this operation, I have noted that I am cutting the flaps broader and not longer. The area I leave undisturbed on the posterior pharyngeal wall corresponds almost exactly with the area which most surgeons use in applying a midline posterior pharyngeal wall flap to the soft palate. The anterior margin of each flap lies immediately behind the posterior tonsillar pillar. Hence the greater the lateral recess, the greater the width of the flap. This has a tendency to standardize the size of the midline velopharyngeal opening which is left. The most obvious correction I would make in my original drawings would be to make the bilateral flaps broader . . .

After the bilateral flaps have been switched and the donor areas on the lateral pharyngeal walls closed, the suction test is tried and if positive the
surgery is over. If the test is still negative, the need for lengthening the soft palate exists. If the patient’s condition is satisfactory, a V-Y lengthening is carried out at once. Your turned-over island flap has been most helpful in closing the defect on the nasal aspect.


This principle builds another bump against rhinolalia. It has some of the advantages of Hynes’ approach with the reduction of the lateral recesses and merely places the bulge on top of the palate instead of at the back of the throat. It also achieves some lengthening of the nasal mucosa.

**CHEEK FLAPS**

Murari Mohan Mukherji of Calcutta trained in Edinburgh under A. B. Wallace. In the 1969 *Cleft Palate Journal* he proposed cheek flaps as an excellent source of “extraneous tissues” for a number of cleft palate babies. In order to avoid creating abnormal anatomy with a pharyngeal flap or going through the difficult stages of an abdominal tube pedicle—and he has plenty of experience with both—Mukherji suggested mucosal cheek flaps. These pedicles are 1.5 cm. wide and 5 to 6 cm. long, based near the anterior pillar of the fauces; care is taken to avoid the parotid duct.
Mukherji noted that these pedicles, when brought to the palatal region . . . are found to fit comfortably between the soft palate and the hard palate, between the four flaps of the universally accepted Wardill-Veau operation. These cheek flaps are safe even with rotation of their bases and have great versatility. They can be used to line the nasal defect in a pushback and be covered with the standard V-Y oral mucoperiosteal flaps.

**Oral Side**

They can be used on the oral side in conjunction with a V-Y procedure.

**Combination**

They can be used in combination, one for nasal closure and one for oral closure, during a V-Y to insure 1.5 cm. pushback.

In 1971, at the Melbourne International Congress, A. C. Ganguli of the Post-Graduate Institute in Calcutta, India, gave Passavant credit for the first use of a cheek flap from the alveolar buccal sulcus. He then advocated bilateral submucous pedicle cheek flaps for both the nasal and oral lining during a releasing pushback procedure. The soft palate was detached from the hard
palate with a through-and-through incision and the soft palate retroposed. The margins of the cleft of the soft palate were pared. A hexagonal flap 1 3/4 inches long and about 1/2 inch wide was cut from the cheek mucosa along the line from the angle of the mouth toward the commissure. The proximal portion of this flap was taken as a submucous, subcutaneous pedicle so that the flap could be pushed under the mucous membrane from the region of the molar tooth into the palate defect with cover to the raw pedicle. The flaps were taken bilaterally, with one for the nasal and one for the oral side. Ganguli noted:

Taking of flaps from the cheek did not produce any functional disability of the mouth. Follow-up study revealed that the length of the palate was adequate and the mobility of the soft palate satisfactory with efficient velopharyngeal closure.

In 1974 Culf, Chong and Cramer of Philadelphia modified the cheek flap for palate defects described by Ganguli. In Symposium on Management of Cleft Lip and Palate and Associated Deformities, with illustrations by D. Leber, they presented their design, applicable when bilateral hemi-palate island flaps were not available.

The buccal island flaps were each outlined as an elongated, diamond-shaped flap avoiding the parotid duct, with the base of the pedicle close to the posterior border of the hard palate but not crossing the alveolar ridge or the pterygomandibular raphe. The buccal mucosa was peeled back to facilitate dissection of a broad subcutaneous pedicle. The soft palate was divided from the hard palate edge in the usual pushback fashion, and the two cheek flaps were interposed into the gaping defect on top of each other, sandwich fashion, for nasal and oral lining.
Ernest Kaplan of Stanford University majored in engineering and minored in art at the University of California, Los Angeles. Thus he was trained in the discipline of measurements tempered with the freedom of art. In 1975 in *Plastic and Reconstructive Surgery* Kaplan proposed a unilateral cheek flap to be turned for nasal lining in any type of pushback procedure when the nasal mucosa has been divided and a defect created. He proposed two possible bases for this flap, which in infants, he suggested, should not be wider than 1.5 cm. (A) The retromolar trigone with the lesser palatine artery in the base of the buccal flap was his favorite. (B) The alveolar sulcus can be used as the base of the flap, but in this case a kink is necessary and the lesser palatine artery is not incorporated into the pedicle.

Using the standard incisions, Kaplan elevates the mucoperios-teal flaps, transects the palatine aponeurosis, cleft muscles and nasal mucosa transversely from the edge of the hard palate, preserves but frees neurovascular bundles, fractures the hamulus, frees the levator muscles from the oral mucosa, leaving it attached to the nasal mucosa, and sutures the muscles and mucosa together. The buccal mucosal flap is cut not to include the buccinator muscle, hinged 90 degrees and pulled through a
tunnel lateral to the greater palatine vessels and sutured into the nasal defect. The mucoperiosteal flaps of the hard palate and vomer are sutured. Kaplan presented diagrams which showed the use of this cheek flap for nasal lining in a von Langenbeck procedure.

There are two other principles by which lining can be supplied to the nasal defect following pushback procedures. They are the island flap and the pharyngeal flap, but both of these will be discussed in chapters of their own.
31. Mending the Misplaced Muscles

The importance of muscles in the palate and pharynx was suspected early, but treatment was misdirected. Fear that the pull of the muscles was responsible for the disruption of the postoperative palate caused fiendish operations to be designed to divide normal musculature to relax wound closure.

Division of Muscles

In 1843 Pancoast modified cleft palate closure by advocating division of palatal muscles and the tendons of these muscles through the Dieffenbach type of incision.

A true interest in muscles in cleft palate was not shown until 1844, when Sir William Fergusson outlined an operation founded on anatomical and physiological data. In fact, he took too much interest in dividing these muscles. These were his words:

With a knife whose blade is somewhat like the point of a lancet, the cutting edge being about a quarter of an inch in extent, and flat surface being bent semicircularly, I make an incision about half an inch long, on each side of the posterior nares, a little above and parallel with the palatine flap, and across a line straight downwards from the lower opening of the Eustachian tube, by which I divide the levator palati muscle on both sides, just above its attachment to the palate . . . then, with a pair of long pointed curved scissors, I divide the posterior pillars of the fauces, immediately behind the tonsils, and, if it seems necessary, cut across the anterior pillars, too; the wound in each part being about a quarter of an inch in extent. Lastly, the
stitches are introduced by means of a curved needle, set in a handle; and, the threads being tied so as to keep the cut edges of the fissure accurately in contact, the operation is completed.

Fergusson admitted:

I have taken no notice of the action of the circumflexus, or tensor palati. I am inclined to think that its action is very limited. . . . I, therefore, without further preamble, propose, as an important accessory to the operation of staphylorhaphy, that the surgeon should . . . so conduct his incisions as to destroy all motory power in the soft palate for the time being and thus permit that repose of the stretched velum which is so essential to a happy result; in other words, I advise the division of the levator palati, the palato-pharyngeus, and the palato-glossus muscles.

Fergusson, repairing hernias in the inguinal region and producing them in the palate, could be dubbed the bad knight of the palate or Sir William the Ripper. He had his favorite thin flat scalpel embellished with a handsome ivory handle, which is on display at the Museum of the Royal College of Surgeons, London. Not only did Fergusson divide muscles, but he inspired others to do the same and more.

In 1846 Liston emphasized the necessity of dividing the tensor palatini muscle. He noted that Fergusson had advised division of the levator palatini and palatopharyngeus muscles with a set of crooked knives. He reasoned:

The union is apt to fail under any circumstances, and I think that this was found to take place in the hands of the above named professor, even after the division of the muscles as he has recommended. . . . If the fleshy belly of the circumflexus (tensor) palati could safely be reached and cut, this would . . . put the parts in a still more favourable condition to come together.

Cutting only the tensor muscle possibly was not too damaging, except for its effect on the function of the Eustachian tube.

Yet during this muscle-cutting era from 1850 to 1900, a multitude of surgeons devoted much skill and energy to dividing such muscle structures as the tensor palatini, levator palatini, palatopharyngeus, palatoglossus and the anterior and posterior pillars of the fauces. The black list during this 50-year period included other renowned names: Sedillot, Skey, Browne, Pollock, Garretson, Avery, Agnew, Warren, Trélat, Schuh, Collis, Ehrmann, Collender, Michael, Whitehead, Verneuil and Casselberry.
Jonathan Mason Warren of Boston, condemning lateral incisions, advised relief of tension by division of the levator palatini and palatopharyngeus muscles. His speech results were probably dismal, but relief of tension must have been achieved, for in 1867 he reported 88 cleft palate successes in closure out of 100 cases.

Dissenters

In 1854 Syme deserved a commendation. Against the popular muscle-cutting stream, he had the audacity and the astuteness to question Sir William Fergusson's myotomy as unnecessary in staphylorrhaphy. In 1865 Annandale condemned extensive myotomy as done by Fergusson, preferring the von Langenbeck procedure in a single operation. He reported that in one of his cases the mucoperiosteum, which obliterated the gap in the cleft palate, had undergone ossification. In 1870 Tait strongly criticized extensive myotomy but advised that the velum be freed from its connections with the anterior and posterior pillars whenever they interfered with its function.

Sir James Berry was born with a cleft palate; needless to say, his speech was far from good. He was therefore undoubtedly acutely aware of the patients' problems, and this sensitivity led him in the natural direction of the least trauma. In 1905 Berry stated his preference for relaxing incisions over myotomies, and in his much-quoted 1912 book, *Harelip and Cleft Palate*, with Legg, Sir James continued to serve as the good knight, championing the stand against muscle-cutting procedures.

Billroth III

Meanwhile, back in the operating room, other less offensive methods of relieving tension were being instituted. More attention was being paid to obtaining good functional results. In 1889 Billroth condemned extensive lateral incisions extending into the velum because he felt these were bound to injure the palatal muscles. He advised section of the hamular process by fracturing it above its connection with the pterygoid plate with a chisel introduced through the posterior extremity of the lateral incision. This is a maneuver that temporarily releases the tensor palati.
action against the cleft suture line. In 1925 Dorrance advocated fracture of the hamulus to aid in the palatal lengthening:

On reaching the tuberosity of the maxillary bone, it will be found that there is still some structure which prevents the palate from falling backwards. This structure is the tendon of the tensor palati muscle. If the hamular process around which this muscle turns at a right angle is broken off, the divided portions will be drawn downward by the pterygopharyngeus muscle. After this hamular process has been fractured you dislocate the tendon of the tensor palati muscle, thus changing its direction so that instead of forming two sides of a right angle triangle it will form the hypotenuse and will allow the lengthening of this muscle and transpose it from a tensor into a levator muscle. This can be demonstrated on any cadaver.

In 1964 R. Ruding of Amsterdam advocated slipping the tensor tendon over the hamulus:

The next step is to lift the tensor tendon from the hamular groove and to detach all insertions of the tendon and the palatine aponeurosis. (Later, after repair, the tensors will have a levator function.) Because the tensor is fibrotic and its tendon difficult to elevate from the hamular groove, it sometimes happens that the hamulus breaks off and disappears. If easily found, it may be removed, otherwise, one may let it go.

JOINING THE LEVATORS

In 1912 Ombrédanne of Paris cut the posterior pillars of the fauces near the uvula and sectioned the aponeurotic expansion of the tensor palati muscle by a blunt-pointed bistoury. Through the same incision behind the maxillary tuberosity, he passed a suture on a Reverdin needle around the levator muscles and sutured them together. Many palates and a world war later, Ombrédanne still preferred this approach for cleft palate.
Franz Ernst, pioneer of dentistry, was a forester's son who rose not only to professional fame but also to a high cultural plane. He played violin in the Academic Orchestra and was honored by Paul Hindemith, who dedicated his Concerto for Greater Orchestra to him, and Goetz, who dedicated the comedy *Hokus pokus* to him. During World War I, he worked in Berlin's Military Dental Institute under Willigen and later under Axhausen. He was the inventor of the Ernst plate made of plastic-celluloid. In 1924 he finished his work on the surgical techniques of handling a cleft palate by plastic surgery.

Ernst is best known to palate surgeons for his development of the "space of Ernst." This is a surgically dissected pocket created by cutting the oral mucosa, the very thin palatoglossus muscle, usually fracturing the hamulus and entering between the pharyngeal constrictor and internal pterygoid muscles—that is, between the masticatory muscles laterally and the pharyngeal muscles medially. He recognized that the musculature of the palate and pharynx had to be reassembled into a position where it could function physiologically. Many surgeons have used the space of Ernst for dissection of the lateral musculature prior to closure of the cleft. Kilner and Peet taught me this maneuver using a blunt dissection down the medial aspect of the medial pterygoid plate to the base of the skull for complete freeing of the structures prior to medial shifting and suturing. Braithwaite based his surgical approach on this dissection.

At the 1964 Hamburg Symposium, A. Immenkamp of Münster/Westfalen, Germany, emphasized the importance of Ernst's pioneer work:

For nearly 30 years I have done cleft palate repairs after the Langenbeck-Ernst-method. I was fortunate to see Ernst perform his method in Berlin. Wide dissection in the space of Ernst and backwards lateral to the constrictor freed the component "muscle block" of the velopharynx, and it assumed a relatively normal position. When doing push-back procedures of the velum we also use lateral pharyngeal space dissection. We have found that with congenital short palates this method suits the retroposing procedures admirably.

In 1977 Otto Kriens of Bremen repeated his concern about dissections and packing in the space of Ernst:
The space of Ernst is a surgically created pocket, which served the purpose to push the velar muscles medially and to accept a pack, which was left there for 8 to 12 days (or sometimes longer!). Preparing the space of Ernst means to operate outside of the pharyngeal or velo-pharyngeal area. According to Broomhead's study, the vascular and nerve supply of the velopharynx enters the pertaining muscle from the outside. Thus entering the space of Ernst means: possible damage to this supply and also: leaving the pathology within the velum proper.

VEAU

One of the major contributions to palate surgery by Victor Veau of Paris, besides his nasal mucosal closure, was his metallic suture of the muscles. In 1927, in the *Proceedings of the Royal Society of Medicine*, he emphasized the importance of a permanent encircling suture of the musculature on either side of the cleft.

Veau made no attempt to correct the direction of muscle fibers or to detach them from the edge of the hard palate. He used the wire muscle suture for simple closure of incomplete clefts or in a V-Y lengthening procedure in complete clefts.

The most honest evaluations of a man's worth must come from his peers. George Dorrance, another palate giant, a contemporary of Veau and one not known for accolades to competitors, once said.
Veau’s contribution to cleft palate surgery is outstanding and admirable. The intramuscular suture introduced by him for cleft palate is unquestionably the suture par excellence. This aluminum-bronze wire is the most practicable form of suture for holding the split anterior segment of the “palatopharyngeal sphincter” in its proper relation. We also agree with Veau that the nasal mucoperiosteum is easily stripped off the nasal surface of the hard palate. However, as yet, we are unable to suture satisfactorily this tissue in its entirety.

**W H I L L I S**

In 1930 J. Whillis of Guy’s Hospital, London, made dissections to establish the muscular identity of Passavant’s ridge. He found fibers of the superior constrictor muscle inserted into the palatal aponeurosis, constituting a lamella which he felt was responsible for Passavant’s ridge and which he called the palatopharyngeal sphincter. In 1958 Calnan did his best to explode the “myth” that Passavant’s ridge participated in the mechanism of speech, for indeed, his observations of the contractions of this muscular ridge showed it often to be below the level at which the soft palate occluded the nasopharynx. Yet, as pointed out by Braithwaite, it is possible that Whillis’ lamella may serve speech by narrowing the lateral pharyngeal recesses and be a factor in palate occlusion of the nasopharynx when the levator sling contracts.

**O L D F I E L D**

The muscular elements of the soft palate, apart from the uvulus muscle and the sphincter of Whillis, consist of four slings. These slings, as noted by Oldfield in 1941, are bilateral muscles gaining their sling-like function through their insertion in the soft palate, the levator and tensor palati with superior origins and the palatoglossus and palatopharyngeus with inferior origins.

**B R O W N E**

Denis Browne, a transplanted Australian and an orthopedic and pediatric surgeon working at the Hospital for Sick Children,
Great Ormond Street, London, always had a salty grain of truth in his criticisms to add sting to the wounds caused by his comments. To know Browne was to know his barbs. He said in 1935:

Brophy's operation appeared to me to be a gross mutilation of the whole dental arch for a purpose that could be easily attained in a harmless way. . . . Lane's operation remains a complete puzzle to me. I have never heard of a good functional result from it, and I do not see how one could be attained. . . . Gillies's operation was not nearly ambitious enough. I wanted better results than speech with the aid of a plate needing extremely skilled dental assistance to fit. . . . Wardill's pharyngoplasty, by which he substitutes for the loose and actively rising posterior half of the sphincter a tight mass of scar tissue which drags the sides of the nasopharynx together, appeared to me to go against orthopaedic principles. Apart from my reluctance to destroy the only normal part of the mechanism I was trying to get to work, I had learnt to distrust the permanence of these draggings together and fixations by fibrous tissue.

By 1932 Browne had decided that the nasopharyngeal passage is closed by the action of two overlapping slings of muscle, the superior constrictor aided by the palatopharyngeus posteriorly, and the levator palati with the tensor palati anteriorly. Resenting a less than 100 percent union of his cleft palates, Browne sought a twofold goal: (1) to remove all tension from the suture line and (2) to leave the joined sphincter in the completely shut position. As he said:

No one would suture a ruptured quadriceps or tendo achillis without leaving the limb so that the joined muscle lay in position of contraction during healing. . . . [so] treat the nasopharynx as one would the mouth of a sack that one wanted to keep shut, and tie a string round it.

In 1935 he described his orthopedic procedure for cleft palate. First he removed the tonsils and cut the posterior palatine arteries. Three months later, and after 18 months of age, he made two breathtaking lateral gashes from the canine tooth in front, backward just inside the teeth, then along the pterygomandibular raphe, cutting the anterior pillars of the fauces off the tongue. No wonder he ridiculed plastic surgeons' horror at large raw areas in the palate region. Blunt dissection through these canyon-like incisions moved the palate elements medially.
CIRCUMPHARYNGEAL STITCH

Then Browne got out his 11/16-of-a-circle needle carrying a double suture of 40-day No. 1 chromic catgut mounted on a pistol-grip needle holder. When aided by his "needle-catcher" forceps, he was able, after much practice, to pass this cord around the back of the throat behind the superior constrictor, exactly in line with Passavant's pad. With a second bite, he completed the buried circle through the two halves of the palate. After the cleft edges had been sutured, the ring stitch was tied snugly and served to splint the cleft union as well as gather the velopharyngeal sphincter with a semi-closed and somewhat rigid ring. In 1948 at Great Ormond Street Children's Hospital, I saw him complete his palate operation in 20 minutes.

Browne reconfirmed his satisfaction with this method in 1955 at the International Congress in Stockholm. He reported spontaneous remarks on improvement in speech by parents and friends of almost every patient. Evidently few, if any, palates dared to separate once he had instigated this purse string. But then, few, if any, separate without a purse string.

In spite of his barbs and because of his work in all aspects of pediatric surgery, Browne was eventually knighted Sir Denis.

BRAINTWAITE

Fenton Braithwaite, a student of muscle physiology, even in his free time concerns himself with muscle coordination, being a director of Newcastle United, a professional football club with a high tradition in England. As Wardill's worthy successor in Newcastle upon Tyne, he continued to improve muscle efficiency in palate surgery. In Gibson's 1964 Modern Trends in Plastic Surgery, Braithwaite described and illustrated the speech mechanism of two muscle slings—the levator, descending on each side from its origin on the petrous bone passing downward and forward, and the palatopharyngeus, passing forward and upward. The levator arch elevates the soft palate in a backward and upward direction while the palatopharyngeus approximates the palatal arches and narrows the pharynx. These two loops with their common insertion in the palate counter each other, and the
pull converts the U loops to Vs and the entire mechanism to an X. When looking through the patient's mouth, one can imagine this muscle action like the opening and closing of a pair of scissors. In profile the effect on the soft palate is shown during contraction of the levator and palatopharyngeus muscle.

Before the patient was 6 months old, Braithwaite united the lip and achieved a one-layer Veau-type closure of the nasal floor and anterior hard palate. Between 1 and 2 years he used a Ganzer-type V-Y operation, but his dissection had a special design. First he elevated his palatal flaps, isolated the posterior vessels and freed the mucosa from the nasal floor. The aponeurosis of the soft palate was divided from the edge of the hard palate, leaving the nasal mucosa intact. The hamulus was fractured and the fibers of the superior constrictor, along with the hamulus, were pushed medially and dissected radically from the medial pterygoid plate. This dissection was carried deep into the space of Ernst and backward around the lateral pharynx, moving the constrictors medially with the soft palate. The edges of the cleft were dissected so that the levator attachments could be divided and freed into robust bundles which were sutured together to close the levator sling. In 1968 Braithwaite reemphasized this maneuver as

of great importance in the production of a palate with maximum mobility. This step consists in the careful dissection of the fan-shaped levator palati following its separation from the posterior edge of the hard palate so that it becomes a compact bundle before it is sutured (with widely placed mattress sutures) to its opposite number.
The lateral spaces were packed with gauze soaked in Whitehead's varnish and left for 10 days to support the sutured palate during the healing phase. Upon removal of the packs, Braithwaite claimed, the space was occluded in 48 hours as the adjacent tissues of the neck moved medially.

It was Braithwaite's theory that, once the superior constrictor's hamular and lateral attachments were freed, the soft palate aponeurosis from the hard palate was released and the levator sling was joined across the cleft, the pull of the sutured levator would maintain palatal length in spite of an intact nasal mucosa.

Spontaneous development of normal speech was usual following modern operations in infancy. Speech therapy was required if speech had not developed properly by 4 or 5 years of age. Braithwaite reported in 1964 that 19 percent of cases required a short interval of speech therapy and 10 percent a longer interval. Seventy-one percent were normal without therapy. Assessment of 290 children over the age of 4 years with operated clefts revealed 58 percent normal, 24 percent with articulation defects (8 percent of these being minimal s distortion) and 9 percent with nasopharyngeal incompetence, incoordination or anterior fistulae. There was another 9 percent not reported.

Cognizant of Braithwaite's priority in construction of the levator sling in cleft palate and his reputation as a silver-tongued after-dinner speaker with an elephantine memory, I challenged him to retrace his early experience. Here are some of his reflections:

When the war came, the leading lights of English Plastic Surgery sprayed themselves and their units to country sites at safer distances from London's centre. I remained at Barts under the "blitz" and, after the war, was transferred to East Grinstead with McIndoe. During the clinics and outpatients I noticed that everyone discussed speech in relation to "Push-Back" of the cleft or short palate. I recalled seeing in various types of injury that the levator palati muscles and the palato-pharyngeus acted as a pair of scissors. This is obvious if the palate or tonsils are touched by a probe; the tonsils are forced inwards, helped by a simultaneous contraction of the upper portion of the superior constrictor. It is also seen, on dissection of a cleft, that some fibres of the levator palati are attached to the posterior edge of the hard palate. If the scissor-like action of the palatal and pharyngeal muscles is to be restored, this complex must be freed of abnormal attachments and...
given normal attachments by surgical suture. This was first discussed by me at East Grinstead in a surgical meeting. It was not met with enthusiasm, being overwhelmed by the popular mixture of "Push-Back" and Passavant.

At Newcastle upon Tyne, to which I was appointed in January 1949, I had the opportunity to try this concept. Dissection of the upper fibres of the superior constrictor muscle from its attachments to the pterygoid lamina allowed a further "pull in" of the superior constrictor. At the same time a blunt dissector could be inserted lateral to the upper pharyngeal muscular group and the latter freed from fascial attachments. The palato-pharyngeus and levator-palatal muscles can be dissected within the soft palate. The fibres of this group are augmented by the fibres which have been dissected from the hard palate and appear as an obvious muscle which just invites suture. These results were presented as routine "follow-up" patients for Dr. Muriel Morley's assessment and criticism. Her opinions of the success of this approach were reported in her well known textbook.

Dr. Betty McWilliams from Pittsburgh visited my unit, to confirm or dispute the results that had been publicized by Dr. Morley on the latter's visit to the U.S.A.

McWilliams recalled her visit with Braithwaite and Morley in Newcastle on Tyne:

A four-year-old with a repaired palatal cleft was finding it difficult to talk to the visiting American, who, his mother had unwisely told him, had come all the way across the ocean on a big airplane just to see him. Needless to say, he was scared speechless. Mr. Braithwaite suggested that an eight-year-old brother be invited to join his little brother in the hope that things would be a bit less tense. The eight-year-old was quite self-possessed and readily entered into conversation. His speech was extremely British and altogether delightful.

Falling easily into the surgeon's trap, I asked Mr. Braithwaite if we could get permission from the boy's mother to tape-record the speech of the older child as an example of not only normal but superior speech in a British male child. Mr. Braithwaite calmly replied, "I repaired his palate when he was a year old." That was a real test of excellence that is usually not possible except in controlled experiments. I did not know the boy's history, and he did not reveal it in his speech pattern. The goal for him had been attained.

Braithwaite concluded:

Delay in publishing these results was due to my feeling that many people published their results too early and with too few examples. Matthew Arnold, the poet, implied in his opinion "the lawless eclectic of a spurious
impressionism” did but ill favour to the uninformed who followed. I did not feel disposed to contravene the couplet:

"Be not the first by whom the new are tried,
Nor yet the last to lay the old aside."

Dr. Morley in 1961 examined 360 children who had been operated on by me according to this technique. The results are recorded in the sixth edition of her book *Cleft Palate and Speech*. I gained comfort from the fact that I appeared to be doing no more harm to my patients than anyone else did to theirs and that I had waited for 360 patients to attain an age of five to ten years before I published the results. This method was discussed as you know at Schuchardt’s Second Hamburg International Symposium in 1964 and presented in Gibson’s 1964 *Modern Trends in Plastic Surgery, I*.

**RUDING**

In 1964 in *Plastic and Reconstructive Surgery*, Roelof Ruding of Amsterdam, the Netherlands, a general surgeon interested in clefts, presented an excellent study of palate musculature with logical suggestions for surgical correction. He noted that the path of the levator muscle lies within the arc of the inferior curve of the posterior rim of the medial pterygoid plate, and upon contraction of this muscle, it moved away from the plate in a posterior direction "much as a slack line leaves the ground when it is drawn tight.” He warned:

Any operation where intensive dissection is done in the region of the posterior rim of the medial pterygoid plate runs the risk not only of injuring the pharyngeal orifice of the auditory tube but also leads to scarring and fibrosis within the levator muscle. Whereas the tensors can be eliminated, the levators cannot be eliminated with the retention of normal speech.

His description of the levator muscle in relation to the palate was concise:

The fibers of the levator pass in three directions. The anterior fiber bundles bend forward in a sagittal sense and insert in the palatine aponeurosis. The posterior bundles bend vertically, coursing downwards, and end in the uvula. The greater and bulkier part of the levator fibers continues between the anterior and posterior fibers to meet in the midline with fibers from the
opposite side. A levator loop is thus created. Starting with the diameter of about 1 cm, this muscle then broadens into a flat muscular sheet measuring approximately 2 to 2.5 cm.

Ruding discussed the two notorious muscle loops:

The combined action of both the levator palati and the superior pharyngeal constrictor on both sides produces the nasopharyngeal sphincter. The lateral fibers of both muscles, coursing to their separate attachments, cross each other. The palatal pharyngeal sphincter of Whillis is comprised of portions of both the levator palati loop and the superior pharyngeal constrictor loop. The posterior portion of the palatopharyngeal sphincter belongs to the constrictor; its anterior part to the palatal muscles. According to Whillis [1930], its anterior insertion is on the palatine aponeurosis, and according to Holdsworth [1951] some bundles unite with bundles of the other side. In both cases we can consider that a sphincter has been formed. Baggerman agrees with Whillis.

Ruding also discussed the palatopharyngeus muscle running in the posterior pillar and the palatoglossus in the anterior pillar, summarizing:

Together with the tongue, these palatopharyngeal and palatoglossal muscle loops form the oropharyngeal sphincter.

He did not give justice to the uvular muscle, stating:

The uvular muscle is not very important and in the surgery of cleft palate is totally unimportant.

(David Dickson, as previously described in “Anatomy,” considers this muscle important with its longitudinal contraction, like the humping of an inchworm, forming the “velar knee.”)

The exciting part of Ruding’s presentation was his logical correction of the misplaced anatomy by surgery. He noted:

In the case of cleft palate, all the muscles and tendons which are normally found do indeed exist, and their origin is the same. It is their insertion which is abnormal. . . . This is particularly true of the insertion of the levator which is the most important muscle. This more anteriorly and medially situated portion of the muscle is called muscle de la fente (fissural muscle) by Veau.

Ruding mentioned that E. Baggerman in Amsterdam had dissected a fissure in which these bundles were macroscopically
well visualized. Just like the lateral portion of the insertion, this medial part was very firmly attached to the mucosa, giving the impression of a scar. Ruding conjectured:

The ideal operation should imitate as completely as possible embryologic development: as the cleft is closed \textit{in utero} in an anteroposterior direction, the palatal musculature also moves posteriorly to finally establish itself in a plane which is posterior to the plane through the hamular processes. The fibers of the musculature, as they follow the closure of the cleft, will change their directions from a nearly anteroposterior one to a nearly laterolateral one, so that when final closure of the cleft is complete \textit{in utero}, all fibers destined to become bundles of muscle will have joined with their partners of the opposite side directly or through the palatine aponeurosis in midline conjunction with each other. Surgically, this can be obtained by carefully detaching every muscle and tendon fiber from their insertions to the bone and then by suturing in the median plane as many as possible of these detached insertions. The more successful this suturing technique, the more muscle fibers will take part in the construction of a true levator loop. . . . The important part is that the muscles, no longer fixed anteriorly and laterally, may now become effective forces modeling function and growth to obtain a more normal closing mechanism.

Ruding also advised ostectomy of the posterior rim of the foramen to let the greater palatine artery move backward and the lifting of the tensor tendon from the hamular groove and detachment of all insertions of the tendon and the palatine aponeurosis without great concern for the hamulus if it should be fractured in the process. He did emphasize dissecting the muscles and aponeurosis from the nasal mucosa and mentioned small lateral cuts for a minor release or larger cuts at different positions for a Z-plasty and even a wide, transverse release to be covered on the nasal side by a free skin graft, as he described in 1955. He concluded, however:

For most clefts of the palate these lengthening procedures are not necessary.

**KRIENS**

In 1967 Otto Kriens of Hamburg had the opportunity to dissect a stillborn bilateral cleft baby in Karfik’s unit in Prague, and found that Veau’s “cleft-muscle” was the common anterior
portion of the levator and palatopharyngeal muscles. The superior constrictor pharyngeus muscle was the only intact muscle sling in the cleft palate. Further study by Kriens of the anatomy and applied physiology of palatal musculature threw some new light on their use in speech and Eustachian tube function. Kriens found:

In the normal soft palate there is the palatal aponeurosis and posterior to this the muscular velum. Muscle fibers of isotonic action intermingle in a predominantly transverse course through the palate.

The three muscular slings of the normal velo-salpingo-pharyngeal apparatus act isotonically. Their contracture leads to the occlusion of the velopharyngeal opening. During the same action, the levator palati elevates the medial edge of the tubal cartilage. This opening movement of the Eustachian tube is furthermore afforded by the downward pull of the lateral edge of the tube by the tensor muscle and indirectly by the levator muscle which elevates the contracting salpingo-pharyngeal muscle.

_Cleft Palate_

Functional synergism of the velo-salpingo-pharyngeal muscles is impaired in the cleft palate with the exception of the superior pharyngeal constrictor. The other muscles of the cleft palate have ipsilateral origins and insertions. The levator palati extends in a bow across from origin to insertion on the same side of the head and thus contracts _laterally_, forward and upward instead of _backward_ and upward. This causes the palatal halves to be pulled to the sides more than posteriorly!

A similar dysfunction is present in the lateral epipharyngeal wall around the levator palati muscle. Since the muscle does not join its mate to move dorso-cranially it deviates instead _cranilaterally_ so that the medial edge of the Eustachian tube is not elevated.
In cleft palate the levator space is retained during contraction of the muscles as long as the cleft-muscle is adherent to its attachments. The detachment from its insertion at the oral mucoperiosteum and from the cleft posterior nasal spine and the formation of a muscle sling through the soft palate are prerequisites for an improvement of an effective interplay of the palatal muscles around the levator space.

_A Warning_

Any intervention near the epipharyngeal portion of the Eustachian tube seems to offer a possible hazard. The fracture of the hamulus may easily lead to a disruption of the musculo-tendinous apparatus near the tube. Worst of all—as far as the subsequent damage is concerned—seems packing of the space of Ernst: immediate disturbance of the equilibrium of the muscle interrelations around the levator space and later scarring.

The attachments of Veau's cleft-muscle, especially its position in relation to oral mucoperiosteum and to the posterior nasal spine, retain the lateral position of the velar stumps and _have to be freed._

Intervention other than elevating the nasal mucoperiosteum and dissecting the fibers attached to the bone should be avoided. If an immediate elongation of the nasal layer is necessary, a retro-displacement after Stark or Cronin or with Millard's island flap should be resorted to instead of severing the muscle attachments at the nasal lining. The latter intervention involves a great risk of a breakdown of the nasal lining with subsequent scars and fistula.

According to Kriens, after the cleft-muscle on each side has been shifted dorsomedially and the levator sling formed, closure of the cleft palate is easy. As Blair and later Widmaier did, he closed his lateral incisions with flaps of buccal mucosa.
Soon after the arrival in Miami of astute Malcolm Deane, a registrar in Bristol on a Maytag Fellowship, we were introduced to the adjunct of direct dissection of the fanned-out levator muscle into two discrete muscle bundles as previously described by Braithwaite. In 1970 a modification of the Braithwaite approach was published with less radical lateral dissections but utilization of his muscle dissections just before dividing the mucosa along the edge of the hard palate—to maintain a fixed point and thus facilitate this part of the surgery. The nasal mucosa is then cut along the posterior edge of the hard palate, allowing the entire soft palate to shift backward. Once freed from their anterior tethering, and developed into two bulky muscle bundles, the levator muscle stumps could be closed into an intact sling by direct suturing. The island flap is then inserted to insure and maintain the retropositioning.

It seemed that if direct levator suturing were used as an adjunct, in addition to the island flap for nasal mucosal lengthening, total palatal function should be facilitated even further.

In 1969 John Hoopes, A. L. Dellon, J. Fabrikant and A. Soliman, using cineradiographic evaluation of the vocal tract with synchronous sound recordings as described by Hoopes and Fabrikant in 1968, found a significant difference between patients with submucous or visible cleft palates and the controls, and also between submucous cleft palate and visible cleft palate groups with reference to one another. They found:

The more anteriorly the levator veli palatini is inserted into the soft palate, the greater is the degree of velopharyngeal incompetence and the greater is the degree of hypernasality (a higher numerical speech rating).

Evidently A. Lee Dellon was a precocious student at Johns Hopkins University School of Medicine. In 1977 he recalled:
Following the first cine studies with Dr. Hoopes, it became clear that for velopharyngeal incompetence, with a cine-documented anterior displacement of the levator, the ideal repair would correct this anomalous location. I was still in medical school and went to the anatomy lab at night, when the students had gone, and took the sagitally sectioned heads, on which the velopharynx was usually untouched, and worked out the procedure. Dr. Hoopes was then at Barnes. I brought Dr. Edgerton to the lab one afternoon with his camera, and he was very supportive of our efforts. To have the least ambiguous clinical trial, I thought we should try this on non-cleft patients with congenital VI, whose only problem was a cine-identified anterior insertion for the levator. We reported our small series (4) in the Surgical Forum first; it later appeared in P and R S. The procedure grew out of a clinical problem, evaluated by clinical research, taken to the lab and then back to the patient.

In 1977 John Hoopes referred to his cineradiographic studies with Lee Dellon as having satisfied him that the position of the levator sling is the important determinant with regard to speech results after palatoplasty. He noted:

On the basis of the investigations performed by Dr. Dellon and myself, Milt Edgerton advocated specific dissection and retro-displacement of the levator muscles. This procedure is theoretically correct anatomically and physiologically; however, the speech results in the limited number of isolated levator dissections and retro-displacements performed in our institution have not been acceptable. I tend to suspect that the poor results are attributable to the excessive scarring associated with extensive dissection within the soft palate.

EDGERTON

Always quite quick to recognize a good thing and to adopt it like "a duck on a June bug," Edgerton was attracted to the levator muscle retropositioning of Braithwaite, Ruding and Kriens. In 1971 with Dellon, Edgerton advocated exposure of the levator muscles through a midline oral mucosal incision in incomplete clefts and congenital palatal insufficiency and through the pared cleft edges in incomplete clefts. They then described dissecting the oral mucosa as flaps off the underlying muscles and continued:
Starting in the midline, the levator insertion (plus a small segment of aponeurosis) is separated from the bony palate and turned posteriorly, taking care not to disrupt the nasal mucous membrane, lying deeply above the soft palate. The dissection is then carried laterally and posteriorly to the point where the cord-like portion of the levator muscle may be seen originating from the lateral pharyngeal wall.

When this dissection has been completed and the levator is freed from connections to the bony palate, there will be a natural tendency of the levator insertion to retract posteriorly toward the uvula. . . . The two levator muscles are dissected free, as if they comprised the “meat” of a sandwich (with mucous membranes forming the “slices of bread” that are left intact on both the nasal and oral surfaces).

At this point in the operation a satisfying relaxation of the entire soft palate may be seen.

This has been an interesting description, but nothing really new has been added to Braithwaite’s, Ruding’s and Kriens’ work. Edgerton’s twist follows:

To help maintain a more posterior position of the levator insertion, we have elected to roll the insertion over on itself 180° before suturing it to the uvulus muscle near the base of the uvula. The oral mucous membrane layer of the soft palate is now closed, if no additional pushback of the soft palate is required.

PERKO

In 1974 Milivoj Perko of Zurich, in an attempt to reduce surgery’s effect on maxillary growth, left the periosteum and the neurovascular bundles on the hard palate. He dissected the oral mucosa as rather hazardous flaps for exposure of palate musculature and detached the levator muscles from the edge of the hard palate, freed them from the nasal mucosa and then united them in a muscle sling.

WALKER

Dennis Walker of South Africa has devised a conservative muscle-releasing trick which he described to me in 1977:

A sub-mucosal muscular release at the back edge of the hard palate is possible by slipping McIndoe scissors transversely between the oral and nasal mucosal layers.
In 1975, while advocating correction of the position of the misplaced levator muscle and contraction of its sling, E. Kaplan reviewed the various methods used by surgeons to accomplish this goal. Braithwaite and Maurice, he noted, originally separated the levator muscle from the nasal mucosa and rotated the halves of the levator muscle and attached oral mucosa together as composite units. Kriens (1969), Millard et al. (1970) and Féra et al. (1970) all advocated methods of levator sling reconstruction during primary closure of the cleft. In 1971 Edgerton and Dellon as a secondary procedure dissected the levator muscle from both the oral and nasal mucosa prior to retrodisplacement. Kaplan then chose the only other possibility: separating the oral mucosa of the soft palate from the palatine muscles so that the levator muscle and the nasal mucosa could be rotated as a composite unit. He argued that this lack of dissection of the nasal palate mucosa produced less scar, less resultant restriction and less risk of devascularizing or injuring the levator muscle.

**RANDALL AND OTHERS**

In 1975 at the Sixth International Congress in Paris, Peter Randall presented an application of overlapping the levator muscles in soft palate closure, similar to overlapping orbicularis oris muscles in bilateral cleft lip. Referring to his overlap, he reasoned:

Hopefully, this tightening of the "levator sling" will produce a better levator eminence and improved V.P. competence.

He advocated a primary procedure with elevation of the usual V-Y mucoperiosteal flaps, dissection with difficulty of the levator muscles from the nasal mucosa, nasal mucosal lengthening with Z-plasty and overlapping of the levator muscle strands prior to replacement of the mucoperiosteal flaps. His design of the criss-crossing muscle overlap following closure was presented along with photographs of the final closure. This much primary surgery in the growing child may not stand the test of time.
In 1975 John Mulliken, F. Giargiana, G. Claybaugh and J. Hoopes of Johns Hopkins Hospital noted some interesting findings in relation to retropositioning the levator muscle:

In our institution, over the past five years, the levator retropositioning procedure was combined with standard Veau-Wardill-Kilner pushback and superiorly-based pharyngeal flap procedure for velo-pharyngeal incompetence; in most instances, anterior displacement was documented on pre-operative ciné study. This retrospective evaluation of our 20 patients has revealed the following:

1.) Combined palatal pushback, levator retropositioning, and pharyngeal flap procedure does not give a change (over 4 mm.) in levator insertion. Only 2 of 12 patients demonstrated remarkable retrodisplacement, and one of these had little improvement in post-operative speech. Yet 10/12 patients demonstrated satisfactory improvement in speech.

2.) Levator retropositioning when employed alone resulted in significant retrodisplacement . . . but the subjective improvement in speech was minimal.

3.) Pharyngeal flap, either alone or when combined with palatal pushback, resulted in anterior levator displacement in 4/6 patients with normal or posterior pre-operative levator position. Yet, speech improvement occurred in all 4 patients.

4.) The post-operative rate of velar ascent was slowed or unchanged following all operative procedures.

These observations indicate that when correcting a pre-operative anterior levator position, the post-operative location of the levator insertion is unpredictable—with the possible exception of levator retropositioning alone. Earlier studies suggest that the island flap pushback and pharyngeal flap also may give predictable levator retrodisplacement.

In conclusion, they made these observations:

Patients with normal or posterior levator insertions pre-operatively all demonstrated post-operative anterior displacement following pharyngeal flap procedures, either alone or in combination with pushback.

Anterior levator displacement may be the result of scar contraction or division of the levator sling (during insetting of a pharyngeal flap).

Toyomi Fujino of Keio University, Tokyo, who trained in the U.S.A. under Bernard, Hoffmeister, Bakamjian and Converse, tries to live by "Ki Shu Butsu Shin," which he translates as "A surgeon uses a devil's hand but with the mercy at the heart of
In the 1977 *Keio Journal of Medicine*, after 20 years’ experience with the Wardill operation, he presented a microsurgical closure of the soft palate cleft in 10 cases. The operation involved a U incision made around the cleft, a whole-layer Z-plasty over the palatopharyngeal muscle just in front of the uvula and oral mucosal flaps (A and B) at the level of the posterior edge of the hard palate (I). Under the operating microscope (5–6 X magnification), the levator muscle fibers were dissected with excellent visualization from the oral and nasal mucosa only two-thirds of the length from the cleft edge to the retromolar region, preserving the lesser palatine nerves. The muscle bundles were transposed into normal position, flaps A and B were rotated and advanced and a full-thickness Z-plasty of the distal velum was accomplished (II). Following suturing, there was an anterior oral raw area between the hard and soft palate (III) which was reported healed in one month. By not exposing the retromolar region and not severing the lesser palatine nerves, Fujino predicted:

*We expect a better growth of the maxillary and palatal bones, and less chance of anesthesia of the soft palate and of atrophy of the mucosal glands.*

The uvular muscle function would also be preserved, but contraction of the raw area is a *drawback*.

Fujino cites a testimonial for his operation from a mother 11 days after surgery on her 19-month-old girl: "Doctor, my child speaks so clearly after the operation." Then speech therapy was discontinued after seven months because of normal speech.

Leonard T. Furlow, Jr., of the University of Florida, who has suggested testing for velopharyngeal incompetence using a film of soap solution over the nares, suggested that his epitaph might read: "His ingenuity was obscured by his procrastination." At the 1978 Southeastern Society of Plastic and Reconstructive Surgeons meeting, in typical low-key manner, he presented his ingenious rendition of palate lengthening and levator muscle retropositioning by means of composite oral and nasal Z-plasties with mucomuscular flaps. One of the nasal mucosal flaps carries the right anterior half of the levator muscle while one of the oral mucosal flaps carries the left half of the muscle. By transposing the four flaps in a double Z he gains 1 cm. in length and lines up
the levator fibers in an intact loop. Here is his description of the method:

The z-plasty closure is loosest at the end of the lengthened diagonal. Thus one can lengthen the palate, transpose and retroposition the palatal musculature, and relax the difficult area at the junction of the hard and soft palate.

The middle limb of each z-plasty lies along the cleft. The ends of the transverse diagonal are at the level of the hamulus, placing one lateral limb approximately along the posterior margin of the bony cleft (A). On the oral side, the posteriorly-based flap is elevated to contain the musculature. The anteriorly-based flap is composed of mucosa only, elevated from the underlying muscle (B). The nasal z-plasty is reversed, so that the posteriorly-based flap contains the muscle of the opposite side and the anteriorly-based flap is of mucosa only (C).

When the flaps are transposed, the muscles are transposed with their posterior flaps into a more posterior and transverse position overlapping to approximate a more normal muscular sling (D, E).

The greater palatine vessels are critical to the oral side flaps. They supply the mucoperiosteal flap on one side and the mucoperiosteal flap and the anteriorly-based z-flap on the other, and absolutely must be protected. If, after elevation of the mucoperiosteal flaps and mobilization of the greater palatine neurovascular bundles, there is any question of their continuity, the z-plasty repair should be abandoned in favor of a straight-line or other more standard repair.

At the time of presentation, Furlow apologized for having only three cases with short-time follow-up. He explained, however, that at the rate he was getting palate cases, by the time he had long enough follow-up he probably would have had only three more.

This is an interesting concept which was applauded by moderator Randall and, in fact, may have potential promise.
In 1978 in the *Journal of Maxillofacial Surgery*, Claus Walter and Hans-Henning Meisel of Düsseldorf proposed a similar type Z of soft palate flaps. With less sophistication in handling the muscles, they noted:

The soft palate is divided into two halves without regard to the muscle fibers involved. This means that no attempt is made to separate the muscle tissue from the nasal or oral mucosa.

They summarized:

With this procedure we are also able to shift the centre of muscle function further dorsally, thus achieving a lengthening of the palate as well.

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Do not forget that many large flaps make much scarring. More important, as in all Z-plasties, the gain in length must be paid for by decrease in width or in side-to-side tightening, which, in even the moderately wide cleft, may cost too much in general restriction.

**THE VELAR STRETCH**

Obviously, since the hole is open at rest, during velopharyngeal closure the soft palate must stretch backward unless the pharynx prefers to project forward. A bit of both is probably the usual phenomenon. In 1969 S. Pruzansky and Robert M. Mason of the University of Illinois first described the velar "stretch factor":

Lateral cephalometric X-rays showed that in some individuals the soft palate (velum) increased in its intrinsic length during velopharyngeal valving. This
"stretch factor" (SF) is significant since the potential of the velum to produce velopharyngeal closure is not always predictable from its resting length. That is, the resting length of the velum may be shorter than the anteroposterior diameter of the nasopharynx.

Among patients demonstrating varying degrees of palatal insufficiency, the SF for the consonant /s/ generally exceeded that for the vowel /u/. The differential is, in part, related to differences in intraoral air pressure, total cavity size, and the muscular effort necessary for their production. The valving differential between these sounds is constant for a given patient but varies between patients . . .

In 110 [adult] patients with congenital palatopharyngeal incompetence, the velum exhibited elevation on phonation without complete velopharyngeal valving. The affected soft palates did not differ from the controls as much in resting length as in thickness. Diminished velar thickness suggested an intrinsic defect in the muscular components that constitute the velum. . . . The SF is an active process . . . dependent on the load imposed, the available muscle mass, the range and speed of movement, and the activity of other muscles involved in the synergy.

In 1972 R. K. Simpson and A. A. Austin measured a 20 percent average increase in the length of the soft palate during activities associated with speech in 20 normal adult speakers. In 1975 Arthur P. Mourino and Bernd Weinberg of Richmond, Virginia, made a cephalometric study of velar stretch in forty 8- and 10-year-old children who spoke normally. They found:

Although 36 children (90%) exhibited velar stretch during the production of /u/ and 32 children (80%) exhibited stretch during sustained /s/, in 12 observations velar stretch was not present during speech. . . . On the average, 10-year-old children exhibited significantly greater velar stretch during both /u/ and /s/ utterances than did 8-year-old children . . . [and only half the amount reported in adults]. These observations suggest that the average degree of velar stretch may increase as a function of chronologic age.

It is vital that closure of the palate cleft not interfere with but facilitate the ultimate velar stretch. Detachment from the bony edge, reconstruction and retropositioning of the levator muscle sling with careful approximation of the remaining velar musculature with minimal scarring set the stage. Interruption of the straight-line scar of union aids stretch, and maintenance of palate lengthening reduces the amount of stretch necessary. Both of
these adjuncts are increased by oral mucoperiosteal pushback relieved on the nasal side by a Z-plasty or, better, by introduction of new tissue such as an island flap, tip of a long pharyngeal flap or cheek mucosal flap or by sliding the nasal mucosa.
Development of the Palatal Island Flap for Nasal Lining

Only after years of observation and experience can one know where the faults lie, gain some understanding of their cause and effects and begin to consider possible solutions. My training peregrinations were a great opportunity to observe many of the palate giants of the 40's. From 1944 to 1959 I saw MacCollum and Douglas do von Langenbeck procedures, Gillies do the Gillies-Fry operation, Wardill, Kilner, and Peet do V-Y pushbacks, Récamier do a Veau closure, Brown, Byars and McDowell do their pushback, Wardill and Hynes do their pharyngoplasties and Denis Browne place his circumpharyngeal purse-string suture. Throughout all of this the shortness of nasal lining concerned me, and in a 1949 discussion with Bill Holdsworth I learned that McIndoe often released the nasal mucosa anteriorly to aid in pushback of the palate.

The Hump

My first observation of a pushback using the horseshoe-shaped mucoperiosteal incision with the division of the nasal mucosa along the posterior edge of the hard palate was in St. Louis in 1950. Of course, as Brown described earlier, he and Byars did not divide the greater palatine vessels but freed them from their foramen and the flaps to facilitate extra lengthening. The impressive pushback then placed the anterior tip of the mucoperiosteal flap all the way back to the posterior edge of the hard palate, causing what looked like a breathtaking retropositioning when viewed from the oral side. There was a noticeable transverse
humping of excess mucoperiosteum on the oral side and also a large raw area on the nasal side. This double discrepancy troubled me, but as Brown had always cut and run before I could phrase a diplomatic question, I finally turned to Byars.

These pushbacks, sir, have a large raw area on the nasal side. There has got to be some contraction?

Beneath his quiet reserve, Byars occasionally allowed a little friendliness to show. He answered:

Yes, but we overcorrect and, by forcing the excess to fold into a hump we counteract enough of the contraction to attain sufficient length.

The authoritative dignity with which this semilogical reply was delivered diverted me for some time.

While writing The Principles and Art of Plastic Surgery, Gillies and I were also operating on a number of secondary palates. As we said in the book:

Too many soft palates are too short and tight, so that speech is far from normal. Anywhere else in the body, when there is not enough local tissue we merely bring in some from afar; why should we discriminate against the palate?

Gillies became interested in introducing a tube pedicle into the palate cleft in secondary cases and later decided to try it primarily in children. He noted that even the Veaus and Kilners could claim no better than 75 to 80 percent good results. He said:

This leads to the supreme question. Can we, in that "other 20%," avoid alveolar distortion, attain good speech and have no call for an obturator? The answer lies in the introduction of new tissue . . . at the primary intervention. Or is this swinging the pendulum too far?

His first primary attempt was made on a little girl who had a wide cleft in a short palate. I assisted and remember that the fat pedicle attached to her wrist was almost too big to enter her mouth. By the seventh day, she had dislodged the pedicle with her tongue.

This served as a challenge for me to take an abdominal tube pedicle into the palate in a bilateral cleft in Korea, thinking that
it would be the first successful primary tube pedicle to the palate cleft. It was not, but this was the last time I ever used a tube. There had to be a better way!

The Scylla and Charybdis of the palate cleft, once two ominous monsters, mortality and infection, had been eliminated after anesthesia, antibiotics and many a surgical Odysseus. In their place stood two lesser monsters, tension and contracture. They now threw an unfavorable shadow on the cleft, particularly when it was wide and the palate short. The majority of clefts were being dealt with quite effectively by popular methods. The closer one approaches 100 percent in any field, the more difficult each of the last percentile points is to earn. Herein lies the challenge.

There was a definite need for improvement as surgeons were acknowledging, even at best, a relatively high percentage of failure: 26 percent in France, 20 percent in England and 25 percent in America. Function seemed to demand effective lengthening in certain cases while the difference in techniques appeared to have only a minor influence. The V-Y pushback, with mere freeing and stretching of the nasal mucosa without division at the hard palate edges, produced limited and uncertain lengthening. Calnan at Oxford, questioning the consistent, long-term effectiveness of V-Y pushback lengthening, cited the scarred area of the common oronasal fistula as a possible factor in subsequent shortening.

There is one "drawback" to all pushback procedures which eventually, at least in part, results in pulling forward what has apparently been adequately pushed back. This is the raw nasal surface, which is in exact proportion to the amount of initially obtained soft palate lengthening. It is elliptical in shape and is created when the nasal mucosal attachment of the soft palate to the hard palate is divided transversely, allowing the soft palate to shift back a centimeter or two. All surgeons who had favored a pushback in short palates had been justifying a small blind spot in principle when they discounted the obvious nasal contracture and binding of the soft tissue with the statement that such length had been achieved that subsequent partial shortening was of no great concern.
Baxter, Dorrance and Bransfield had applied split-skin grafts to this area. When successful, these reduced contracture, but, as J. B. Brown pointed out, they were responsible for a foul odor caused by discharge pooling on the skin graft.

Some surgeons advocated freeing and posterior advancement of the nasal musoca of the hard palate. In 1957 Cronin in Houston developed a right-angle scalpel which he suggested be passed through the nose for division of the mucosa. Yet my experience with dissection of nasal mucosa from the hard palate is that it is blind and bloody and can be troublesome when the tissues are thin and begin to tear. Advancement posteriorly of the total nasal mucosa is not easy even in complete clefts where access is at least possible along the cleft. In incomplete clefts, where palate shortness is often of major concern, the dissection is still more difficult.

There are some surgeons who feel that attachment of a posterior pharyngeal flap to the velum brings about palatal lengthening. It would seem that any ultimate lengthening achieved when a routine pushback and a pharyngeal flap are used must be merely the result of a tug-of-war between the two raw contracting surfaces, one on the nasal side of the soft palate pulling anteriorly and the other on the underside of the pharyngeal flap pulling posteriorly. Surely \textit{two raw wrongs do not make a right}, as evidenced by the pharyngeal flap tenting the posterior pharyngeal wall as a restricting synechia, dynamic or not, which anchors the velum and limits its freedom. Its primary advantage is that it succeeds in reducing the size of the velopharyngeal aperture; however, its unphysiological characteristics caused a continuation of the search for a more natural way to maintain lengthening in a pushback.

\textbf{M A K I N G \ A N \ I S L A N D \ O F \ T H E \ H U M P}

Recalling again and again the excess oral mucoperiosteum invariably humping up in the pushback flaps used by Brown and Byars, I finally decided to take the hump for a better purpose and to accomplish the shift by the island flap principle.
Repertorial Felix Freshwater, in 1978 a precocious plastic surgery resident at the University of Miami, in 1975 called attention to the little known fact that in 1831 Philippe Blandin of Paris seems to have been the first to conceive the island flap principle. He reconstructed a cancerous nose with a forehead flap which had the skin portion of its pedicle divided but retained its communication with the blood vessels and nerves and in 1836 pointed out that the use of this principle would reduce torsion.

In 1893 Theodore Durham of New York described a two-stage procedure which first transposed a skin flap of scalp to a face defect and later returned the skin pedicle but retained a permanent, buried vascular pedicle. Not until 1898 did George Howard Monks of Harvard Medical and Dental Schools independently describe the island flap in the Boston Medical and Surgical Journal. He was indeed a remarkable surgical pioneer, innovative and artistic, having been trained in anatomy by Oliver Wendell Holmes at Harvard and in sculpture by Ernst Hahnel in Dresden. Then, too, he had a touch of gamesmanship, having invented Halma (the Greek for leap), a game that became extremely popular throughout the world as the forerunner of Chinese checkers.

For a lower eyelid defect following excision of an epithelioma, Monks dissected the superficial temporal artery and veins as a stalk the length necessary to reach the eyelid, and then, for the termination of the unit, cut a crescent of hairless skin. He wrote:

I now had hanging from the region of the temple a long pedicle of subcutaneous tissue containing the artery, and attached to the end of it, a crescentic bit of tissue of the full thickness of the scalp and covered with skin.

Through a subcutaneous tunnel in a form of "Greek leap," he passed the island through and sutured it into the eyelid defect, noting:

I had a little fear that it would slough for, even when it was in place, the strong pulsation across it from end to end was sufficiently reassuring.
In 1917 Esser described use of the island flap by means of the external maxillary artery.

The total efficiency of the island flap principle has always fascinated me. In Korea in 1955 I used it for eyebrow reconstruction, remarking:

In spite of the fact that in many clinics an aura of fear seems to hover above the "island flap," if Monks did it in 1898 and Esser in 1917, it deserved a try.

There is a generous blood supply to palatal mucoperiosteal flaps, not only from the descending palatine artery entering through the greater palatine foramen but by equally adequate subsidiary vessels, such as the ascending palatine and the palatine branch of the ascending pharyngeal artery, as well as branches from the tonsils and cheek. In fact, Dorrance, Wardill and Denis Browne all intentionally divided the posterior vascular bundles without endangering the mucoperiosteal flaps.

Thus it was conjectured that a greater neurovascular bundle could be dissected free from the underbelly of the main flap forward to an anterior portion of excess mucoperiosteum (the hump), which could be cut loose to dangle as an island.

The island flap was dissected out on cadaver palates without difficulty and was found not only to flip over with mucosa facing nasally but also to turn 90 degrees to fill and be sutured into the transverse releasing gap in the nasal lining. In fact, a preserved human hemi-head was carried about in the trunk of my car for many months to make possible an immediate scientific demonstration of the island flap should any student ask even the most haphazard question. Reactions varied from satisfaction to subliminal shock.

The first case was operated on September 12, 1960, at Jackson Memorial Hospital, Miami. The patient had an extremely wide cleft in a deficient palate that had had previous work in Illinois. The neurovascular bundle was dissected without difficulty and the mucoperiosteal island was cut free. For further mobilization, a block of the posterior bony wall of the foramen was resected with a chisel, as advocated by Limberg. The island flap turned as white as chalk. The neurovascular pedicle was massaged gently
and turned at various angles without color improvement. The prognosis was guarded, so I decided to place the island, not into the nasal defect out of sight as planned, but longitudinally in the oral closure of the cleft where it could be observed, the hope being that it would regain its vascularity and survive. It remained white, became necrotic and debrided itself, leaving a defect which healed by scarring. Then the patient, for economic reasons, returned to the Illinois area and has been followed by Sam Pruzansky.

**MAKING THE LONG COUNT COUNT**

It was the seventh round and Jack Dempsey’s persistent punching had finally put Gene Tunney down. In the confusion, Dempsey was standing over him until the referee finally motioned him to his corner and started counting ten of the famous “14 count.” There was Tunney on the canvas with a choice of lamenting his miserable position or figuring a way to get out of it. As pointed out by Mosey King, my boxing coach at Yale, Tunney took the famous long count to realize that Dempsey’s left hooks were responsible for his plight and, when he rose, he had the sense to backpedal to his own left and away from Dempsey’s vicious hook. This “thinking while down” retained for Tunney the World Heavyweight Championship and along with it, a check for 1,000,000 dollars.

This same principle has been of value to me several times when I have been “sitting on the canvas.” While the blanched island flap was becoming necrotic, the idea of a palatal island was not condemned, but blame for its first failure was given, if not to injury and scarring from previous surgery, to arterial spasm following injury during ostectomy. The next island was soon maneuvered into the nasal defect and sutured without need for a bony foraminal resection, and the island retained its normal pink color at all times.

Once the method was mastered, it became almost routine. On one day at Kingston Public Hospital, Jamaica, three island flap palate lengthenings were accomplished, and K.P.H. chief plastic surgeon Kenneth McNeill was impressed with the soundness of the approach and the relative ease of its execution. He later reported his experience with the method. We also noted a
smoother postoperative recovery after coverage of the nasal raw
area, avoiding the usual discharge, discomfort and ultimate
distortion.

In April 1961, at the meeting of the Southeastern Plastic
Surgery Society held in Williamsburg, Virginia, this palatal island
flap was first presented. The principle of the island flap with 14
successful cases was published under the title "Wide and/or
Short Cleft Palate" in Plastic and Reconstructive Surgery in January
1962. The first illustrations of the technique showed the early
islands to be small (1 to 2 by 2 to 3 cm.), as seen in a short
incomplete cleft.

The same procedure was sketched again by Shirley Durkee in a
complete cleft after first-stage closure of the anterior cleft with a
vomer flap.

Previously inevitable contracture was now avoidable by the
insertion into the gap of this stiff vascular island. With such a
"filler" available, the nasal mucosa of the soft palate on either side
of the cleft could be divided and pushed back more radically. An
extra dividend was thus provided. Each soft palate half not only
advanced posteriorly in the lengthening process but also shifted
medially toward its mate across the cleft to be sutured with
relative ease in the midline.
In 1963 in *Surgery, Gynecology and Obstetrics*, from the experience of 20 cases, I began to elaborate on the description of the flap in more detail:

All available mucoperiosteum is elevated from the hard palate in one flap for incomplete clefts and in two flaps for complete clefts. These flaps are peeled off the bone down to the posterior edge of the hard palate. The aponeurotic and mucosal attachments are divided along the edge of the hard palate which opens an elliptic gap in the nasal mucosa and allows the soft palate to advance toward the pharynx. On one side the greater palatine neurovascular bundle coming out of the greater palatine foramen is freed and dissected forward off the under belly of the mucoperiosteal flap with scalpel, scissors, and scaler. The required elliptic area of mucoperiosteum is taken from the anterior extremity of the flap, cut free and is left dangling on the neurovascular bundle. It can be turned over quite easily with its mucosa underneath and fixed into the nasal gap with No. 4-0 chromic catgut sutures.

The remaining portion of the pushback is routine and consists in Limberg's ostectomy, [partial or complete] bundle freeing on the opposite side plus bilateral hamular infraction, and posterior advancement and fixation of the mucoperiosteal flaps. The intact mucoperiosteal flap is brought across the midline slightly to offset the donor defect of the flap from which the island has been removed.

**LARGE BIPEDICLE ISLAND**

Most early island flaps were unilateral, being taken from one side and based on the neurovascular bundle of the same side. Yet by 1963 the value of bilateral neurovascular pedicles was realized as the double base allowed a larger island to be taken from the
mid-anterior position. The bilateral “bucket handle” approach was found of special value in incomplete clefts with extremely short halves, as well as in short palates following operations in which no primary lengthening had been attempted. The double-pedicled island was preceded by a standard Dorrance dissection of the mucoperiosteum.

This double-pedicled island can lengthen the soft palate one-half the antero-posterior length of the entire hard palate. It does, in fact, offer all the advantages and almost none of the disadvantages of the later-described use of bilateral total hard palate mucoperiosteal flap (sandwich) procedure.

**TWO ISLANDS FOR TWO PLANES**

An occasional palate cleft is so extremely wide that there is not enough tissue present to allow closure without such side-to-side tightness as to impede palate function. These are the cases in which speech obturators, tube pedicles and pharyngeal flaps have been advocated, none of them offering an ideal solution to the problem.

In 1966 in *Plastic and Reconstructive Surgery* the use of two island flaps was advocated, one for the usual nasal lining defect and the second to be introduced into the actual cleft on the oral side to reduce the side-to-side tension of direct closure. Division of the nasal mucosa from the posterior edge of the hard palate not only allows retropositioning but also facilitates medial advancement of the lateral elements a moderate amount. One island
will fill the pushback nasal gap. If the mucosal edges of the cleft are turned over, they can be joined for the nasal closure more easily in the midline, but the oral edges of the cleft are left gaping. The second island can be fitted into this defect to obtain closure without tension. The remaining mucoperiosteal flap ends are advanced posteriorly as they rotate together medially and are sutured over the nasal island and down to the edge of the hard palate. Of course, it is necessary to retain enough mucoperiosteum in the main flaps for adequate posterior advancement of 2½ to 3 cm. on the oral side. Any mucoperiosteum anterior to this, once the hard palate cleft has been closed, can be considered expendable for island use. In only an occasional case, however, have two island flaps been required.

The first case of "two islands" is still the most exciting one. The patient was a pleasant, attractive 13½-year-old Cuban girl who had emigrated three years before to Miami. She had a small ventricular septal defect in addition to a severe unoperated cleft of the soft and posterior third of the hard palate. Examination in 1962 by the South Florida Cleft Palate Clinic revealed:

not a great deal of tissue in the lateral palatal shelves and close to unintelligible speech, aided by grimacing with nares collapse.

She was subsequently seen by three qualified plastic surgeons who considered her unsuitable for surgical closure and recommended an obturator. Dr. George Balber, prosthodontist, agreed with these findings and expressed the opinion that, from previous experience with such wide clefts, an obturator offered the only chance for improved speech.
As this patient had excellent teeth in good occlusion, I was unwilling to condemn her to an obturator for the rest of her life. In spite of the expertly compiled evidence to the contrary, surgical closure was carried out on July 8, 1963. With the patient on prophylactic penicillin for her cardiac condition, two island flaps were developed, the nasal mucosa was divided along the hard palate for retropositioning and one of the islands was used to maintain this length. An attempt to approximate the palate halves caused such tension that a superiorly based pharyngeal flap, 1.2 cm. wide, was sutured into the entire extent of the soft palate cleft on the nasal side. The oral side was closed without undue transverse tension with the aid of the second island.

Evaluation by a speech therapist two months postoperatively revealed great improvement in speech but marked nasal emission of air and sound. Cinefluorographic examination showed a soft
palate with moderately good mobility making borderline contact
with the posterior pharyngeal wall. The patient was enrolled in a
weekly speech clinic at the University of Miami. It was reported
in 1966:

The only functional detraction in the velopharyngeal mechanism seemed to
be the tight synechia of the pharyngeal attachment. The purpose of the
pharyngeal flap had been to supply lining tissue to ease closure on the nasal
side so that those normal palate muscles present could function unimpeded.
Thus, division of the synechia was contemplated. However, this was post-
poned and over the years its presence apparently has become acceptable.

When the postoperative patient entered the speech clinic in 1963 she had
nasal emission on all fricative sounds and a pronounced facial grimace,
constriction of the nares. After 3 months she could produce the "s" sound
in the initial position without nasal emission of air and with reduced facial
grimace. Eighteen months later she could use "s" in single words, phrases
and, finally, in conversation. After 2 years of therapy the patient's articula-
tion test revealed no errors, her fricative sounds had no nasal emission, her
oral resonance improved and her facial grimaces had been virtually elimi-
nated. Cinefluorographic analysis on December 21, 1965 revealed a palate of
average length and thickness with good mobility. The palate consistently
achieved velopharyngeal closure with the middle third of the soft palate
making pharyngeal contact at the level of the hard palate. Discontinuance
of speech therapy was recommended.

A dividend gained from the introduction of the island on the
oral side has been the chance to follow up and study this flap
under direct vision in its new habitat. It does not show evidence
of contracture, it maintains its rugae and, in fact, it continues to
look and act like the mucoperiosteum that it was and is.

In my original paper I had diagramed the common procedures
used for lengthening the palate, indicating each method of
dealing or not dealing with the nasal raw area. Inadvertently, I
omitted a diagram of Cronin's hard palate nasal mucosal slide-
back which stimulated a lovely letter from Cronin to the Editor.
He noted that the author had included the V-Y, the Dorrance
and the Gillies-Fry, but:

He ignores the use of the most obvious and natural source of coverage:
namely, the mucosa from the floor of the nose, the use of which I described.
Cronin did acknowledge:

The island flap would seem to be a worthwhile addition to the armamentarium of the palate surgeon.

He then began his offensive:

However, obvious disadvantages are apparent. . . . As Brown has mentioned, skin grafts in this area may be a source of crusting and odor. It is possible that the mucoperiosteal flap, being covered with squamous epithelium, might also give rise to the same problem. The mucosal flaps from the floor of the nose are, of course, covered with ciliated epithelium and goblet or mucous cells, making the accumulation of crusts unlikely.

Although neither patients, parents, doctors nor nurses had noticed any foul odor associated with the island flap cases, not until five years later was I able to answer Cronin's challenge. In 1967 as an R. W. Johnson Fellow, Ron Pigott of Bristol, with a nasendoscope, gazed down upon a number of our mucoperiosteal islands. Later, with J. F. Bensen and F. D. White, he reported a small collection of mucus over the area of the island but no evidence of crusting or foul odor.

When viewing the island flaps from above, Pigott also noticed that some of the islands showed slight humping. This was thought to be caused by a dead space with its hematoma—and scarring between the island and the covering mucoperiosteal flaps. Since then a through-and-through suture from the mucoperiosteal flaps has been used to pick up the island flap while carefully avoiding the main vessels.

MENDING THE LEVATOR MUSCLES

After 10 years' experience with the island flap, attention was directed to the correction of the misplaced levator muscle fibers in conjunction with the use of the island. As I commented in 1970:

A pushback palate closure, augmented by an island flap, allows division of the abnormal anterior attachments of the levator veli palatini muscles and allows their retropositioning into a more nearly normal position. As noted by Hoopes et al, "The broad closure obtained by the posterior displacement of the levator insertion is the consequence of the island flap procedure introduced by Millard."
Stimulated by Maytag Fellow Malcolm Deane of Bristol, I began, à la Braithwaite, to dissect the fanned-out levator muscle into two discrete muscle bundles. This dissection was done just before dividing the mucosa along the edge of the hard palate—to maintain a fixed point and thus facilitate that part of the surgery. The nasal mucosa was then cut along the posterior edge of the hard palate, allowing the entire soft palate to shift backward. Once freed from their anterior tethering, and developed into two bulky muscle bundles, the levator muscle stumps could be closed into an intact sling by direct suturing. The island flap was then inserted to ensure and maintain the retropositioning of muscle sling and soft palate. It was conjectured:

Certainly if direct levator suturing is used as an adjunct, in addition to the island flap for nasal mucosal lengthening, total palate function should be facilitated even further. Another 10 years will tell.

Nine of the 10 have passed as of 1979.

REDUCING THE FISTULA FORMATION

The use of a portion of the mucoperiosteum as an island to line the nasal side reduces the available amount of cover for the oral side. Consequently an increase in anterior fistulae might be anticipated.

In the early island flaps, all possible mucoperiosteum was elevated from the hard palate to be used as the island—or in the V-Y advancement. Fistula complications were further com-
pounded by the absence of mucoperiosteum in the vicinity of the fistula, making secondary closure most difficult.

During the 1966 survey, the number of fistulae found was exceptionally high. The technique was therefore modified, and a triangle of mucoperiosteum was preserved in the midline anteriorly over the incisive foramen in incomplete clefts (A). A wider triangle was left over the area of the previous anterior cleft closure in the complete clefts (B). As experience with this method was gained, the reduction in fistulae was assured, partly because of the change in technique, partly because of better selection of cases.

Although far from an asset, it is of interest that the fistulae had absolutely no effect on the length of the palate or on the speech results. This finding may be explained by the small size of the fistulae and their far-anterior position. (In the usual V-Y palate procedure, fistulae are prone to occur more posteriorly—at the junction of the hard and soft palate, where Calnan considered the scarring to be partly responsible for loss of the length gained during the original V-Y pushback.)

A BENEFIT OF EXPERIENCE

After 200 island flaps over a 10-year period, the operation should be getting reasonably easy to execute, particularly as it has never been nearly as difficult as surgeons expect. In 1970 I stated, as encouragement:

The island flap part of the surgery is easy, as it is done under direct vision. Experience has reduced the time required; the average case with a palate closure, levator muscle dissections and nasal mucosal release with an island flap takes about 45 minutes. The percentage of the time used on the island flap seems worthwhile. (Scalpel dissection of a neurovascular bundle usually takes less than a minute, while division of the mucoperiosteum to free the island, and suturing it into the nasal defect, takes less than 10 minutes.)

SAFETY IN DISSECTING THE BUNDLE

Probably the most intimidating aspect of an island flap is the thought that it is necessary to dissect out the individual vessels.
No—this should not be a daredevil procedure! Cut so to leave a subcutaneous sleeve around the bundle for protection. This is quite an easy maneuver when dissecting the bundles under direct vision from the underbelly of the thick mucoperiosteal flap. Try not to buttonhole the main flap, but if you do, stitch it up.
33. Other Surgeons Accept The Island

H A G E

O N July 16, 1959, during intermission at the Royal Opera House, Covent Garden, at the time of the Second International Congress held in London, I first had the honor of meeting the sage Jacobus Hage of Tilburg, the Netherlands. He had the unique aura of stoical courage and honorable loyalty about him which pervaded his entire life right to the bitter end, reminiscent of the original "Dutch boy" who held his finger in the hole in the dike to save his homeland from flooding.

In 1962, during one of his work trips to the Dutch West Indies, Hage consented to return home via Miami, and during his visit a palatal island flap was demonstrated. He agreed with the logic of the operation and in 1964 reported, from his Plastic and Jaw Department at St. Elizabeth Hospital, his own experience both in Archivum Chirurgicum Neerlandicum and at the Hamburg International Cleft Palate Congress. He presented an ingenious diagramatic cross-section series to demonstrate the island flap action and noted:

The technique as described in his articles, and the operation as I saw it performed by Millard himself, have entirely convinced me of the value of the method. . . . If lengthening procedures involve the oral side of the palate alone, no actual lengthening is obtained, since the velum also has a nasal lining that needs lengthening. Transection or merely mobilization of the nasal mucosa near the border of the hard palate does not seem to give any permanent results—not even after grafting . . . —due to subsequent con-
tracture. Filling the gap with a pedicle flap of the posterior pharyngeal wall seems to be a non-physiological procedure. . . . Due to its excellent vascularity and its rigidity, the island flap gives permanent and stable velum lengthening.

For extra lengthening, Hage suggested:

I have occasionally employed two island flaps for nasal lining, placing one transversely behind the other to fill in the gap.

Hage closed the anterior palate at 6 to 12 weeks and, using a Dorrance or Wardill-Veau-V-Y procedure, divided the nasal mucosa and inserted one or two islands at 1 year. He placed great value in a positive suction test through one nostril, with the other closed, at the end of surgery to determine the passive closing capacity of the velar valve. Hage also recorded the gain in length by means of radiopaque tracers, not only a few days postoperatively but also after three months, and published diagrams of the results in 1966 in the *British Journal of Plastic Surgery*. Three examples are shown here.

He noted:

My early results in primary lengthening of cleft soft palate (with or without a cleft anterior to it) have been so satisfactory that it seems justified to give a preliminary report. . . . Yet it will take a long time, and a large series before the final results can be evaluated in the form of improved speech, for speech is the main criterion for good soft palate surgery. . . . Not only in wide primary cleft palates is Millard's island flap useful, it can also be indicated in primary lengthening of a cleft soft palate. However, Millard's flap has a definite place in secondary lengthening procedures of the velum. It is thought that the indication for such can be based on four considerations:
1. Direct inspection—if the velum is short but the mobility is good, then this lengthening procedure is indicated.

2. Speech evaluation—by a speech therapist who finds nasality and other imperfections due to incompetent velopharyngeal closure which in turn is due to a short, and not an immobile, velum.

3. X-ray examination—to confirm previous conclusions.

4. Intelligence test—some cases are incurable due to low intelligence and other mental insufficiency which an island will not greatly aid.

If the postoperative palate with poor speech checks out on all four tests, these seem to be the cases *par excellence* for secondary lengthening with an island flap. Hage concluded:

Although the use of a pharyngeal flap is thought to be less "physiological," there still seems to remain an indication for a pharyngoplasty, *e.g.*, in too short and/or badly moving soft palates.

In a personal letter to me in 1970, Hage suggested that the island flap possibly was not indicated during the primary surgery in the young child and should be reserved for secondary lengthening. At the time I disagreed with him, but time and Berkowitz have won out with me and I look back at Hage's warning with humility.

One of my last communications from friend Hage was in October 1971, when he wrote:

Untreatment of cleft palates would give 100% of nasality in speech.

Primary closure of the palate now-a-days gives 2/3 or 70% good speech.

A secondary operation again will cure 2/3 or 70% of these unacceptable speeches. The residue of less than 10% can be satisfactory but is still a challenge for the future.
WITH PEET

During a 1965 International Congress in Bratislava, a mutual friend, Czechoslovakian professor Stefan Demjen, organized, in his clinic behind the Iron Curtain, a true Anglo-American cooperation. A patient with a short cleft palate was anesthetized, gagged and marked for an island flap. Then Eric Peet executed the Oxford V-Y technique in his usual impeccable style. Once his dissection was completed, he moved over to allow me to prepare the neurovascular bundle, cut the island free, release the nasal mucosa from the hard palate to obtain the desired lengthening and insert the island flap. Peet completed the suturing of the cleft. I could see he was pleased with the result of our teamwork and asked him his opinion. He admitted:

The island flap is a good idea and no doubt will be found of value, particularly in short incomplete clefts where our percentage of good speech results has been less.

AN ENTHUSIASTIC SWITCH

On September 28, 1961, before the American Society of Plastic and Reconstructive Surgeons in New Orleans, M. T. Edgerton presented a paper entitled "Surgical Lengthening of the Cleft Palate by Dissection of the Neurovascular Bundle." Under the subtitle "Palatoplasty techniques to lengthen mucosa on the nasal surface of the palate," he laboriously outlined everything he had been able to find in the literature by anyone or think up on his own. This was published in *Plastic and Reconstructive Surgery* in May 1962, where he again itemized the various nasal lengthening possibilities:

1. Undermining and advancement of nasal cavity mucosa
2. Anterior or midpalatal relaxing incisions in nasal floor
3. Lining epithelial inlays grafts
4. Z-plasty of margins of nasal mucosa
5. Vomer flaps
6. Anterior obturators with deliberate fistula
7. Extraoral or buccal mucosal flaps

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Absolutely no mention of the mucoperiosteal island flap was made although the method had been presented by me 14 months before and published five months previously. Edgerton explained that, in over 500 palatoplasties at the Johns Hopkins Hospital since 1947,

we have employed various combinations of pushback operation.

He concluded by advocating sharp dissection of the neurovascular bundles and added:

Of course, [it] may be combined effectively with Z-plasty of the nasal mucous membrane and various types of elongation techniques of the palatal flaps themselves.

At the 1961 New Orleans meeting I approached Edgerton after his paper and told him of the island flap design:

Milt, you are close but not quite there. All you have to do is cut an island off, leaving it attached to the freed neurovascular bundle and use this piece of mucoperiosteum to lengthen the nasal side.

He admitted that it sounded like a good idea and promised to try it. He later asked if it were possible to cross the midline with the island.

On August 24, 1962, I wrote encouraging him again to try the island:

Dear Milt:

. . . What I am really writing you for is to encourage your use of the island flap. The more I use it the happier I am with the pushback results and in the hands of a surgeon as skilful as yourself, it would receive its ultimate effect.

His letter of December 12, 1962, in response indicated that finally he had followed the suggestion:

Dear Ralph:

. . . I have followed your suggestion on two or three occasions and found it really useful.
Dr. D. Ralph Millard, Jr.
2121 Biscayne Boulevard
Miami 37, Florida

Dear Ralph:

Thank you for note calling attention to the problem of the septum for closure of a defect in children with cleft palates. Am glad to hear you continue to like the island flap with pushback surgery. I have followed your suggestion on two or three occasions and found it really useful. Incidentally, would you be good enough to send me a couple of copies of your various publications on cleft lip and palate surgery for use in the plastic library. By the way, I enjoyed your description of your visit to the West Indies very much.

Sincerely yours,

Milton T. Edgerton, M. D.

A last letter to Edgerton:

Dear Milt:

Thank you for your letter and I am pleased that you have found the island flap useful. I can now answer a question you posed to me last June. Several days ago, I did a secondary pushback on an incomplete palate which had been closed many years before. I took the mucoperiosteal flap from the anterior portion of the flap crossing the midline for about one-third of its size. There was a scar across the island. There was no difference in the color of the island and there was a bleeding edge distal to the scar. There has been no difficulty with the flap as far as I can tell since the operation and therefore, although this is only one example, it indicates that you can take a flap with at least a portion of it across the midline.

Then Edgerton in 1965, writing in the December Plastic and Reconstructive Surgery:

Over the past five years, the Plastic Service at Johns Hopkins Hospital has employed two surgical operations for obtaining velopharyngeal closure in patients with defective palates. . . . One of these operations (the island flap push-back) is being used with increasing frequency by the author for all types of congenital clefts.
He represented the technique of the island flap used in the usual nasal lengthening, offering nothing new except lovely drawings by the Johns Hopkins University artist.

The absurdity of this 1965 claim is highlighted by the facts presented. Two days after Christmas 1965, when I first read his article in the December Plastic and Reconstructive Surgery, I flew to Philadelphia, took the train to Harrisburg and spent several hours with Dr. Ivy going over my records and correspondence. A stopover in Philadelphia gave me a chance to repeat the discussion with Peter Randall. Later gentle Ivy advised that, rather than publish my (scorching) Letter to the Editor, it would be better to have Edgerton write a letter of apology. His belated acknowledgment in 1966, ending with "the credit for the first description of this technique belongs to Dr. Ralph Millard," never quite covered the issue as there was never any question of priority. His retrograde inference of independent conception of an island for nasal lengthening is disclaimed. Independent conception can and often does happen to all of us, but in this instance, it so happens that the records disprove the claim.

VILAR-SANCHO ALTET

The vigorous Beneto Vilar-Sancho Altet of Madrid, Spain, spends several months each year in submarine archeology, exploring shipwrecks on the bottom of the Mediterranean Sea, diving from Ibiza, the smallest of the Balearic Islands. He has reclaimed from the sea parts of hulls, anchors and many double-handled am-
phorae from the ruins of Roman and Carthaginian ships dating back as far as the second century B.C. His wife, Pilar, always dives with him so, as he says, "to stand guard against the sirens." This off-island diving has kept him in shape to do a multitude of Spanish palatal island flaps. His first publication in 1966 varied the design by leaving a large triangle of mucoperiosteum anteriorly over the incisive foramen and cutting off one entire palate mucoperiosteal flap as the island, instead of using the lopsided V-Y posterior advancement. He presented a movie on the island flap in 1967 during the International Congress in Rome.

In 1971 Vilar-Sancho wrote:

We have carved out about 175 island flaps of which about half were in secondary palate repairs.

What we like best about this operation is how easy it is to carry out, the considerable lengthening obtained, together with the versatility of the use of this island flap.

What we like least is the possibility, although remote, of losing the island flap, which leaves us a very difficult problem to solve.

DIJKSTRA

R. Dijkstra of Zwolle, a cross-country skater and a trainee of Hage, in 1969 wrote in the British Journal of Plastic Surgery of using an island flap as a secondary lengthening maneuver. He suggested calling the procedure a "release" rather than a "pushback," and his diagrams demonstrated use of unipedicle and bipedicle islands. He reported:
The lengthening achieved was found to be permanent in the majority of cases, but the effective lengthening was limited to a maximum of approximately 10 mm.

It was Dijkstra's impression that the results were better than those previously obtained with simple pharyngeal flaps . . . [but] the method is not universally applicable. . . . Lengthening is obviously of no avail in the paralysed palate, and probably not in the congenitally short palate. Also island flaps are not advisable in the badly scarred and collapsed hard palate, for technical reasons.

In 1977 Dijkstra stated that he no longer uses the island flap, preferring the superiorly based pharyngeal flap advanced so the tip closes the nasal defect. He outlined his reasons:

1. I consider the pharyngeal wall a more expendable donor site than the palatal vault.
2. The operation is easier to perform.
3. Apart from the palatal lengthening (which I agree is essential), this operation provides for a certain narrowing of the pharynx.
4. The island-sandwich is rather bulky and often seems to effect some descent of the palate.

GEORGIADE

We had the pleasure of Nick Georgiade's company on one of our Jamaican work trips in the middle 60's, during which several island flaps were used. Since then, in 1969, Georgiade, Mladick, Thorne and Massengill reported preliminary evaluation of the island flap in cleft palate repair. They used bilateral neurovascular bundles in incomplete clefts.

In complete clefts, they used a unilateral pedicle, dividing a large mucoperiosteal island at an angle which did not allow V-Y retropositioning on the oral side and thus might conceivably have reduced the possible overall lengthening. They particularly mentioned leaving a nasal mucosal cuff (arrows) along the edge of the hard palate to facilitate suturing the island flap. They made several other salient points:

In our experience, the intact untraumatized bundle provides excellent vascularization for even the largest of the island flaps. The firmness of the island helps support the repair and gives a two-layer overlapping closure in
the area of maximum tensions. . . . We have found some definite limitations with this procedure. In clefts with narrow arches and/or wide complete clefts, it is difficult to get a sufficiently wide island flap. Without a large island flap the pushback effect is limited. The width of the island flap determines the extent of the pushback and, unfortunately, no matter how long the island is made, its width is predetermined by the distance from the alveolar ridge to the cleft. The operation takes approximately thirty minutes longer than a simple pushback. In a few adult cases we have found extensive arborization of the neurovascular bundle which hinders mobilization of the vessels. In one adult case, there was a portion of a flap that was definitely compromised, possibly because of the division of the many branches during mobilization.

REICHERT

In 1969 Heinz Reichert of Stuttgart wrote:

Finally, in the palate, by using flatter and wider pieces of bone graft, we have been able to obtain a smooth vault and avoid affecting later growth. Collapse in the premolar and molar region no longer occurs. Both secondary closure of the soft palate at 3½-4 years and also later palate lengthening by Millard’s island flap in short palates are made considerably easier by the existence of an intact bony palate.

MARCHAC

The suave and talented Daniel Marchac of the Children’s Hospital, Paris, was a Maytag Fellow in Miami in 1966. In 1970, in *Vie Médicale*, he outlined the various procedures being used to augment the velopharyngeal sphincter. In this paper he expressed his
approval of the island flap in primary and secondary velar lengthening. His diagrams of the secondary procedure are of interest.

During a 1977 visit to Miami, he confirmed his continued use of the island flap principle in secondary cases.

TAKAHASHI

In 1970 the energetic Shojiro Takahashi of the Tokyo Dental College, who had also observed the island flap pushback procedure in Miami, published in the *Japanese Journal of Oral Surgery* a complete cross-section list of palate-lengthening procedures and, I am relieved to say, in Japanese diplomacy at its best, included the Cronin method. His diagrams of his rendition of the island flap lengthening were presented.
In 1972 he kindly forwarded me photographs of his use of the island flap nasal lining during a pushback, showing (1) nasal lining defect after release, (2) dissection of neurovascular bundles, (3) island flap, (4) completed operation.

In 1977 he wrote:

The island flap method is excellent, but it leaves rather large raw surfaces in the hard palate. I have used the island flap method in about thirty cases. Recently we have been using it on wide or short cleft palate, and in adult patients.

NOORDHOFF

In 1970, in *Plastic and Reconstructive Surgery*, M. Samuel Noordhoff of Taipei, Taiwan, reported successful treatment of five difficult secondary palate cases which had had previous surgical procedures resulting in complete or partial dehiscence, scarring, velopharyngeal incompetence and unintelligible speech. He combined a pushback procedure with an island flap and a pharyngeal flap. Elevating two mucoperiosteal flaps, he took an elliptical island from the lateral aspect of the better one. Freeing the soft palate from the hard palate by dividing the nasal mucosa and scar presented a defect into which he turned the island flap.
The island was attached to the edge of the hard palate by sutures through drill holes.

In 1977 Noordhoff reaffirmed:

The island pedicle flap is extremely useful in severely scarred, short, tight palates where previous surgery has resulted in a cleft palate disaster. In these cases I use a push-back palatoplasty with island pedicle flap and inferiorly based pharyngeal flap. The island pedicle flap allows a release of the tight, scarred palate posteriorly. An effective release is not possible by a simple push-back procedure and the island pedicle provides the means to do it. These patients need 1 to 2 years before they can develop normal speech. Blood loss is frequently severe. The results have been extremely encouraging. This week a 1½ year postoperative patient came in who has developed normal speech from unintelligibility. I do not have statistics on this as we are in the process of calling in old patients.

To relieve side-to-side tension in closure of the soft palate, Noordhoff followed my suggestion of turning up the edges of the cleft for oral closure and introduced a superiorly based pharyngeal flap for nasal closure in four of the cases. His conclusions were logical:

Changing lines of stress from scar contractures is a consideration in all aspects of plastic surgery—an example being the Z-plasty. Such a concept is also applicable in scarred palates. The release of scar contracture posterior to the palatine bone, with interpositioning of the mucoperiosteal island flap, changes the direction of the lines of tension—possibly resulting in gradual reabsorption of collagen and softening of the palate. The pharyngeal flap contributes to decreased lateral tension, as well as narrowing the velopharyngeal space.

The softening and increased mobility of the palate seem to take a considerable amount of time—at least one year. The improvement in speech is gradual in these patients. . . . The combined operation used in these is not recommended for all secondary operations for velopharyngeal incompetence. More simple procedures, such as the pharyngeal flap, may be all that is indicated when there is good palate mobility and lateral movement.

HOOPES

John E. Hoopes of Johns Hopkins Hospital, Baltimore, has been using the island flap to line the nasal side of the pushback
operation since 1965. These are diagrams of his rendition of the island flap.

Convinced of the importance in speech results of the final position of the levator sling postoperatively, Hoopes wrote me in 1977:

It has been my feeling that the island flap pushback palatoplasty is the only procedure which results in significant retro-displacement of the levator sling. I have, therefore, in my personal series utilized (almost exclusively) the island flap pushback for repair of cleft palate. Needless to say, I was distressed by the data in the recent paper published by Drs. Luce, McClinton, and myself. It is imperative now that I extract from the data those island flap pushback procedures performed only by myself—in that I, personally, have had no postoperative fistulae, and my patients have not (inordinately) required secondary pharyngeal flaps. In spite of the data, I continue to utilize the island flap pushback—simply because I have no other procedure available to me which significantly retro-displaces the levator sling.

I must admit that Hoopes’ reasoning seems sound, and any further data he uproots will be of interest.
DAVIES

David Davies of Capetown, South Africa, since 1964 has resorted to total closure of the entire cleft of the lip, alveolus, hard and soft palate in one stage at about 3½ months. In 1971 he noted:

The lip is repaired with a Z-plasty, the alveolar defect [bone] grafted, and an extensive pushback done with the use of a Millard island flap.

He has the impression that the longer, more mobile palate is giving better speech results. He does not agree with orthodontists' objections to an island flap causing a large raw area and the resultant scarring causing collapse. The raw area epithelializes for him in two to three weeks. No decrease in vault space has been noted in any of the cases.

Since 1973 H. Wolfgang Løskren of Pietermaritzburg, South Africa, trained by Davies in Capetown and as a Maytag Fellow in Miami, has also been carrying out the total cleft closure according to the Davies plan, including the island flap. His one improvement is the use of the rotation-advancement lip closure.

"SANDWICH" FLAPS

In 1967, in the British Journal of Oral Surgery, F. T. Moore and J. Kenneth Chong of Queen Victoria Hospital, East Grinstead, Sussex, England, noted, much as I had five years before, the
consequences of dividing the nasal mucosa during the Veau-Wardill V-Y retropositioning of the palate.

The raw area on the nasal aspect of the junction of the hard and soft palate heals by secondary intention, scars and contracts as it heals, thereby reducing the gain in length of the soft palate to negligible proportions.

They presented their modification of the island flap principle and dismissed my previous work (1962, 1963) as “small elliptical island flaps taken from the anterior hard palate.” Moore and Chong advocated taking almost the entire mucoperiosteum on each side based on a neurovascular bundle. After dividing the soft palate from the hard palate by a through-and-through incision, they inserted the two islands into the defect in double-decker style, one for nasal lining and the other for oral cover. Likening this to a “sandwich,” they predicted permanent lengthening equal to half the maximal width of the hard palate. They reported 40 such cases “with 8 requiring Moore’s lateral pharyngoplasty” in addition.

Actually, my first paper in 1962 described small flaps, but the paper in 1963 showed the anterior half of the hard palate being carried on bilateral bundles, which maneuver gets every bit as much into the lining as the straight sandwich. In 1966 I described two larger flaps, one placed transversely in the nasal side and one longitudinally in the oral side—“double-decker” in
principle as a crisscrossed "sandwich." This approach actually, in addition to nasal lengthening, achieved side-to-side release not possible with the straight sandwich.

In 1973 J. P. Bennett, while still at the Queen Victoria Hospital, reported a follow-up on F. T. Moore's cases and the present procedure at East Grinstead:

The sandwich pushback is the first procedure wherever possible. If, after an adequate period of speech therapy, nasal escape is still present and further improvement from surgery can be expected, a lateral pharyngoplasty is carried out. Only a few patients do not achieve normal, or at least acceptable, speech following these two procedures and in such cases, it has been recently found that a Rosenthal pharyngoplasty can produce further improvement.

Out of 80 patients reviewed, 42 had gained normal or acceptable speech. Of the 33 cleft palate patients treated by sandwich pushback and lateral pharyngoplasty, 17 had achieved normal or acceptable speech. Of 6 patients treated by all three operations, 3 had achieved normal speech.

Of special interest were 25 patients suffering from suprabulbar paresis, out of which 14 achieved normal or acceptable speech. More important may be the fact that the troublesome problem of dribbling saliva in these patients was relieved following the sandwich pushback, probably because the palate lengthening improved the act of swallowing.

J. Kenneth Chong, born in Malaysia, was trained in medicine at Oxford University and St. Bartholomew's Hospital, London, and in plastic surgery at East Grinstead. In spite of having suffered burns of his hands, treated with skin grafts, he has superior manual dexterity. Like a bumblebee carrying pollen from garden to garden, Chong, after his flight from Sussex to Pennsylvania in 1967, soon had the "sandwich" blossoming in Philadelphia. In 1973 Culf, Chong and Cramer of Temple University presented the method at the Duke Cleft Palate Symposium, noting:

The most ideal situation for this type of operation was in those patients who demonstrated a short but mobile and supple soft palate without significant scarring and a velopharyngeal defect of less than 1 cm. The relative width
and length of the hard palate was a decisive factor in determining whether this particular procedure would be carried out. If the hard palate was narrow, either because of scarring, a particular patient’s anatomy, or previous incisions in less than ideal positions . . . another type of operation would be done . . . As one can see from these criteria, the ideal candidates were those with submucous clefts or patients who had had previous palatoplasty with short mobile, minimally scarred palates and hypernasal speech.

Specific details of their rendition of the double-decker sandwich island flaps are of interest:

They are designed so that the lateral incision is made 2 to 3 mm. from the dental-gingival margin, and, on making the medial incision, a 3 mm. midline mucoperiosteal strip is left in situ. This medial strip serves two purposes. It decreases the possibility of reopening of the previously repaired cleft. Second, it assists with closure of the flap donor site by proliferation of mucosal cells.

The island flaps are developed as described often before, but these authors seem to feel the need for extra freedom:

An ostectomy of the posterior medial portion of the canal is then done to allow retrodisplacement and mobility of the neurovascular bundle. After the ostectomy, further gentle mobilization of the vessels is carried out so that in changing the axis of the flap from longitudinal to a transverse one, the pedicle will not kink.
Of course, it is the unnecessarily wide, blunt, distal end of their island and the short stalk of their bundle that makes this maneuver awkward and difficult, requiring foraminal ostectomy. Even the three C’s admit danger with ostectomy, a danger I experienced in my first case. They warn:

It is usually preferable to do the ostectomy prior to making the posterior cut (between the hard and soft palate), so that if the vessel is injured in this maneuver, a different plan can be carried out.

They then extend their posterior incision across the central intact strip and, gaining control of the nasal mucosa with sutures, make a through-and-through incision dividing the soft palate from the hard palate about 3 mm. posterior to the bony edge. They noted:

It is important to carry this incision well laterally to ensure complete transection of the levator aponeurosis and nasal mucosa. The dissection is then continued laterally and posteriorly, including the insertion of the tensor palatini if necessary. Blunt dissection progresses until the soft palate has been adequately pushed back and stays there without traction. . . . Therefore the width of the island flaps should be equal to the width of the defect.
One island flap is flipped over and transposed as nasal lining, and the second island flap is transposed over it as oral cover.

Culf, Chong and Cramer presented the combination of double hemi-palatal island flaps and a wide superiorly based pharyngeal flap. The distal end of the pharyngeal flap was denuded of mucosa and threaded through a submucosal tunnel in the velum. Lateral ports were ensured with No. 8 FG catheters.
They also noted the possibility of combining one hemi-palatal flap with a cheek island flap when the double palate islands were not available.

Robert B. Winslow, trained in island flaps at Temple University by Cramer and Chong, reported in 1974, with Bradley, Warren and Bevin of the University of North Carolina:

Bilateral island "sandwich" flap combined with a superiorly-based pharyngeal flap is an operation designed to restore V P competence. The efficacy of this operation was determined by measurements of V P competence and these results were correlated with observed speech changes. It appears that this operation is safe and reliable as a means of reducing V P sphincter size, restoring V P competence, and favorably modifying the associated articulation-voice quality problems.

They made some comments about the island on the oral side which could be observed postoperatively:

Although we cannot supply documentation now, in every case we have noted an increase in the length of the palate during the postoperative recovery period. It appears that what was originally an elliptical island in the soft palate slowly becomes circular or even rhomboidal. The long axis (transverse) shortens and the short axis (antero-posterior) increases. Theoretically, this may be due to scar contraction with the longer scar contracting more and forcing the "islands" to change their shape in a manner that lengthens the palate. In addition, contraction of the pharyngeal flap might "pull" the palate posteriorly.
AN EMPTY SANDWICH?

The sandwich principle, although it offers permanent lengthening, is probably overrated. First, it takes almost all the mucoperiosteum covering the hard palate, a loss that in the young, growing patient cannot be tolerated. In the adult, there should be no trouble. Two elliptical flaps—and they should be elliptical to fit the defect and not blunt-ended—one on top of the other, will interrupt the scar contracture, but with far more scarring. I much prefer to take the anterior half of the mucoperiosteum on bilateral bundles, which gives as big a flap for the nasal lining release, and, without cutting a second island, merely slide backward the intact distal half of the mucoperiosteum and attach it to the edge of the hard palate. Remember, the transverse release of the soft palate from the hard palate must stop at the most lateral edge of the hard palate on each side; thus the amount of possible pushback is limited. The attainable amount of pushback can be achieved just as well with the bipedicle island, or a simple larger island as with the sandwich and with less double-decker theatrics and scarring in its wake.

OTHER OPINIONS

Many surgeons favoring other techniques have noted the value of the island flap. In 1972 David Sullivan of Spokane, who uses the two lateral pharyngeal flaps, did admit:

I have found your turned-over island flap of palate mucoperiosteum most helpful in closing the defect on the nasal aspect.

Hector Marino of Buenos Aires wrote in 1972:

As for the island flap, I must say that I was the first to demonstrate it in Buenos Aires, during surgical sessions held in the Instituto de Quemados for the Latin American Congress. I am totally pro it as it is the soundest method to prevent the nasal contraction of the pushed palate. Besides, the dissection of the palatine arteries has ended all the trouble caused by the stretching of them or the Limberg demolition of the canal. The only drawback in my particular case is that, as I have the doubtful privilege of operating many secondary cases, I have seldom an unscarred mucoperios-
Sebastian Rosasco of Buenos Aires wrote in 1976:

We would like to clarify that the number of island flaps operated by us is 162. Our results have been very satisfactory; we have applied your island flap procedure, together with the mobilization of other flaps, in one step, as shown in the diagrams of a complete cleft.

We consider of real importance: (a) the closing in one step because it reduces the percentage of wound disruptions, and (b) at an early age, 18-24 months old, because of difficulties with closure, plus the pathological speech patterns are more difficult to correct when closure is performed at an older age. However, our enthusiasm has been diminished recently by a publication of Ralph Blocksma. . . . They have observed that this trouble of the development of the maxillae is evident in the 10 years follow-up, and is common to other procedures that dissect the mucoperiosteum of the hard palate. . . . Have you had trouble with the developing of the maxillae in follow-up of more than 10 years? At what age have you done the dissection of larger mucoperiosteal flaps of the hard palate?

In 1974 Demjen wrote:

In Millard's island flap procedure, . . . the posterior flaps or flap remain without benefit of blood and nerve supply from the posterior neurovascular bundle. This procedure is gaining popularity around the world. Yet there were no reports of complications in healing or necrosis of the posterior flaps and no observations of atrophy of the soft palate or disturbance of the growth of the maxilla attributable to this step of the surgical procedure.
In 1974 in the President’s Address at the meeting of the Royal Society of Medicine, F. L. F. Innes of Norwich expressed enthusiastic approval of the island flap in lengthening the palate during a pushback operation. In the 1976 Proceedings he stated:

The Kilner-Wardill operation on the palate does not elongate the palate very much because the nasal mucoperiosteum does not stretch sufficiently. . . . Division of the nasal layer without filling in the gap is no answer because of the high incidence of breakdown of the repair with a one-layer closure and because of the scarring which inevitably occurs on the exposed nasal surface of the buccal flaps, impeding the movements of the palate as well as causing shortening. A brilliant solution to this problem has been presented to us by Ralph Millard (1963). The Millard island flap is a triangular piece of mucoperiosteum, isolated from the anterior end of one of the "V" flaps of the Kilner-Wardill operation except for its stalk of posterior palatine vessels. This very mobile piece of tissue can be turned over easily, with its epithelial surface uppermost, into the gap after dividing the nasal layer. It elongates the soft palate in a most remarkable fashion. The Millard island flap is in my opinion the greatest advance of recent times in the surgery of the cleft palate. I have used this flap occasionally in the primary repair operation performed at the age of one year, when it looked as if the soft palate would be grossly deficient, but it need not be introduced as a routine in the primary operation for the simple reason that the Kilner-Wardill operation itself is sufficient. The Millard island flap is, however, the greatest possible assistance when the soft palate is deficient, as it is, for example, in the submucous cleft palate. The procedure is in my experience without any faults. It is safe and efficient, and it is an elegant application of the principles of plastic surgery. The division of the nasal layer should be radical, carried well out to each side, and the Millard island should be of generous dimensions so as to fill the gap without tension. . . . For some time, I have been doing the two procedures—the Millard island flap and the Hynes pharyngoplasty—at the same operation and I can recommend the combined procedure with confidence as perfectly feasible. It has produced results which are far better than I have previously obtained. . . . If the Millard island flap operation on the palate and the Hynes pharyngoplasty are to succeed there must of course be unimpaired movements of both the palate and the pharyngeal wall. If the movements are deficient, the result of surgery will be less than hoped for. . . . Both procedures appeal to me because they enhance the mechanism of closure of the isthmus in a natural fashion. Pharyngeal flap operations, whether based above or below, are unnatural. To have to use them is, in my opinion, an admission of defeat. I do, however, perform a
pharyngeal flap operation if I am confronted with a palate which does not move properly or if the combined operation which I have mentioned fails, as it does occasionally, to provide an efficient mechanism. Most of my failures are due to poor or inconsistent palatal elevation. For these cases one must accept that the palate has to be tethered to the pharynx by a pharyngeal flap.

STEELMACH

At the Sixth International Congress held in Paris in 1975, Rudolf Stellmach of Berlin stated:

There is no problem to lengthen the oral side by the use of the V-Y technique and setback of the pedicle flaps. But it is rather difficult to lengthen the nasal side as much. Most promising so far is the dissection of nasal pedicle flaps according to Cronin or the use of the island flap proposed by Millard.

RINTALA

Aarne Rintala of the Finnish Red Cross Hospital, Helsinki, wrote in 1976:

The diagram of our modification possibly needs some explanation. The pushback is achieved by a transverse incision and the island is inserted on the nasal side as big as possible. On the donor area, between this and the other flap to the oral side, we leave a narrow strip of oral mucosa attached to the peristome reaching down to the border between the hard and soft palate. The flap to the oral side to cover the nasal flap is cut as big as possible, even bigger than the first one, and rotated down to cover the defect in the soft palate. In this way, I am trying to put the most tension transversely in order to avoid secondary shrinkage of the lengthened soft palate. The anterior middle edge of this oral flap is sutured tightly with one stitch to the narrow mucoperiosteal strip left in place in the midline of the hard palate. This is done because otherwise the edge of the oral flap will have a tendency to protrude downwards into the mouth as a hanging flap, probably because of its size and the rotation.

As far as I can remember, we have not lost a single flap. Neither can I remember now any other major complications. The method has been very successful in closing fistulas, in these rare cases where it has been used. The primary lengthening of the palate has been on the average 10-15 mm. There has been some secondary shrinkage, but not very much. It looks like the palate would be permanently lengthened in practically every case.
In 1977 in Toronto, at the Third International Congress, Aarne E. Rintala and S. L. Rantala reported having used their modified island flap operation on 57 secondary palate cases (4 to 27 years of age) with persistent nasality and unsatisfactory speech with a nasopharyngeal gap not exceeding 12 mm. at phonation, as estimated by lateral radiography. Results: 90 percent achieved 1 cm. or more length. There was noticeable decrease in nasality in 68 percent with no change in 30 percent. Lateral radiography in phonation of sss revealed lengthening of the palate in 63 percent. The authors noted:

Preoperatively no velopharyngeal closure could be observed in any of the patients. Postoperatively definite, or probable but not constant closure was detected in over 50 percent. The general quality of spontaneous speech was estimated good in 58 percent, and there was considerable improvement in 51 percent. . . . Summarizing, the island flap as a secondary procedure seems to improve the speech in a majority of patients, but relatively seldom results in complete disappearance of nasality, and fully normal speech. . . . Probably the island flap as a secondary procedure should be reserved to selected cases with a tight but mobile velum, slight nasality and a nasopharyngeal gap not exceeding 5 mm. at phonation. An advantage of the method is that it is no "final" operation, and if the result should not be satisfactory, a pharyngeal flap can still improve speech.

MAISELS

In 1976, more than 10 years after he had been a Maytag Fellow in Miami, the sound David Maisels wrote of his interim experience with the island flap. He had assisted me on numerous cases in which this technique was used and therefore I was interested in his report.

I employ the fairly standard V to Y pushback with Veau flaps. When I first returned from Miami, I was using an island flap virtually routinely in all cases, but as time has gone on, I find myself doing so less frequently. I think the main reason for this was that I had one or two cases in whom I got such a marked pushback that the anterior palate repair was left unsupported by an oral layer, and in one case I had a fistula here, which of course was not very easy to repair, because most of the good tissue had been pushed back. I have found that as I become more radical in my deep pterygoid dissections and hamular fractures, as outlined by Braithwaite, there are fewer and fewer cases.
in which I am forced to use an island at the primary operation. I still use it from time to time in secondary repairs in order to obtain more length and in those primary cases with the typical V-shaped cleft where I just cannot get a decent closure by the standard methods.

FURNAS

David Furnas of the University of California in Irvine is an articulate, humorous and ingenious surgeon who received some of his early training with Conway where pharyngeal flaps were popular. Nevertheless, I gambled on his versatility and asked him if he had any experience with the island flap. As he has a clever way with words, they are included verbatim:

I have had some experience with palate lengthening with your island flaps, and feel that it is an elegant procedure. My experience has diminished in recent years because I have been doing primary pharyngeal flaps at the time of my palate repair. . . . An island flap dramatically rescued me in a patient several years ago. I was supervising Harlan Wald, and the case was a primary pharyngeal flap in a one-year-old child. When the flap was sutured into place, the suture line showed unmistakable signs of tension. Despite much discussion, cogent comments on how wounds relax as they remodel, and assurances from the first-year resident that everything would be all right (particularly his weary ischii), the tension was unchanged after ten minutes of collagen remodeling. Then the elegant maneuvers of the island flap came to mind (much like the coconut palms of a Pacific atoll might heave into view of a drifting, shipwrecked seaman). In a few minutes the island was in place, serving as a bridge between the posterior nasal layer of the palate, and the anterior layer of the pharyngeal flap. The tension in the flap, and the operating room, was completely dispelled. The patient has perfect toddler's speech now.

PERSONAL OBSERVERS

Palate surgeons have not yet taken to the island flap as much as I would have hoped. There seems to be an inherent hesitancy to attempt to dissect an island. It evidently is a "see one, do one" procedure, for most surgeons who have observed the operation are pleased with the ease of execution and return home to use the procedure. Of course, only those who have observed firsthand the
use of an island flap in a pushback operation are in a position to
give a clear opinion of the approach. Thus comments from
surgeons who have been invited to observe one or two examples
of the surgery are pertinent. Hage, Takahashi, Georgiade, Maisels
and Marchac have watched and then gone on to do the procedure
routinely. A very special guest to observe the island flap was
Robert H. Ivy.

Ever since Ivy, as editor, accepted my first rather atypical paper,
"Plastic Peregrinations," for publication in Plastic and Recon-
structive Surgery, we had been friends. In his later retired years, he
accepted several visiting professorships at the University of
Miami, and in 1972, during one of these, he was invited to
observe an island flap pushback. This is a simple procedure often
accomplished in 45 minutes. After the surgery we went over to
the adjacent blackboard to diagram in review the specific steps
taken in that case. Then I turned to Ivy, who although humble,
unassuming, diplomatic and extremely knowledgeable was above
all else honest, and asked him what he thought of the operation.
He answered in typical, straightforward, simple prose:

The best thing you could do.... Got it all over the pharyngeal flap in my
opinion.

Peter Holm of Copenhagen, after observing an island flap
pushback operation on May 17, 1974 stated:

Most plastic surgeons doing palate surgery claim they do a pushback
operation—I have seen a lot of palate surgery but no pushback until today,
my own surgery included. So much about the pushback itself—another
question is how often a pushback is needed.

THE DIEFFENBACHS

With his father professor of philosophy at Königsberg and his
mother the daughter of the eminent German poet Ludwig
Gottfried Kosegarten, Johann Friedrich Dieffenbach, the famous
cleft palate pioneer born in 1792, is the taproot of this family
tree. When Kenneth Dieffenbach, now a New Orleans plastic
surgeon, came to Miami on a Maytag Fellowship, he acknowl-
edged being a sixth-generation descendant of the first Dieffen-
bach in America, the family sharing a grandfather with the celebrated surgeon, eight generations back. Kenneth's great-great-grandfather was the first native pipe organ builder in America, and Kenneth still plays one of his organs. As a third-year clerk at Germantown Hospital, he watched Hans May do the first cleft palate surgery he had ever seen, following the operation with May's Second Edition lying open on the windowsill. Frustrated by an inconsistency in a drawing in the book, Dieffenbach trailed May to the dictation room, with the book under his arm, for an explanation. There was an error in the drawing, prompting May to ask his name, and when he got "Dieffenbach" in reply, he quietly opened the book to the dedication to Johann F. Dieffenbach. Dieffenbach then began a nomadic training in palate with Marcks, Latham, Cannon and finally Hoffman in New Orleans, where as chief resident on the LSU service he got to do his first cleft palate pushback. He recalled:

Bill Pollock of the Tulane Service, working next door, peered in momentarily with the question ...: how was I going to cover the nasal surface of the soft palate defect? I realized that I had not even released the nasal side, much less lined it. With this burning provocation, the next pushback received an island flap, taking one and one-half hours, with no difficulty and in fact, with surprising ease. My only reservation was in regard to the aura of fear and cautioned restraint expressed by others about the technical application of the flap.

After residency, he took postgraduate training with Converse in New York and a Maytag Fellowship in Miami. As he said:

Fresh with functional velar results of Hogan's lateral ports, I landed in Miami to see how the fearsome island flap was done "at home."

After scrubbing on an island flap pushback, he gave this response, but one must remember his background for generations has been philosophy, medicine, music and poetry!

Watching the 290th Miami island flap absolved any hesitations I still had. After smooth scalpel dissection of the neurovascular pedicle had freed the island in no time at all, it was demonstrated with acrobatic ease that this nomadic flap could be plugged anywhere in the hard or soft palate. Tucked behind the hard palate on its back, it left the uvula curled gently against the pharynx when all was done.
MAILLARD

Gaston F. Maillard of Lausanne, Switzerland, a 1976 Maytag Fellow, observed an island flap palatal pushback and was asked for his reaction to the procedure as his previous training with Dufourmentel, Tessier, Clodius, Meyer and a stint at Canniesburn, Glasgow, Scotland, had been exceptional. This is what he wrote:

As a European trained in traditional schools, V-Y retropositioning and posterior pharyngeal flaps, I have to say you have to see it to believe it! In fact, it is difficult to imagine that by releasing the lining from the hard palate free edge, the most important defect lies on the nasal side. The oral is easily closed by the usual pushback. After having seen it, I am now convinced that, compared to the pharyngeal flap, it is a more physiological way to achieve the closure. On the other hand, it is a truly exciting plastic procedure: a double axial pattern island flap turned upside down at 90 degrees.

CARNEIRO

In early 1978 a bipedicle island flap was used to lengthen the nasal lining during a pushback in a 24-year-old Cuban girl who had had a von Langenbeck operation in childhood. Ronaldo dos Santos Carneiro of Porto Alegre, Brazil, a Maytag Fellow, expressed enthusiasm for the procedure. I asked him why.

I trained in Allentown, Pennsylvania, where one attending surgeon did Langenbecks and the other two did V-Y pushbacks and all feared a breakdown at the join of the hard and soft palate where often only one-layer closure is possible.

The island flap impressed me because of the ease of dissecting the neurovascular pedicles, ease of maneuvering the island into the nasal defect, and the amount of lengthening obtained. Also, the most troublesome area at the junction of the hard and soft palate received the best closure. The pharyngeal flap is not the only weapon against palate shortness.

WILLIAMS

It is interesting that Sidney Williams of Kingston, Jamaica, who trained with Braithwaite in Newcastle for four years from 1960 to
1964, explained in 1978 his infatuation for the past 10 years with the island flap:

In wide clefts with the Braithwaite approach, I had difficulty getting and maintaining a closure at the junction of the hard and soft palate. The island flap made this easy so I have used it many times.

CUBICCIOTTI

Gildo Cubicciotti of Naples, Italy, had been observing in Miami about two months. After the sixth pushback-island flap, he exclaimed at lunch in the Jackson Memorial Cafeteria one day in 1978, in mild excitement:

The first thing I’m going to do when I get back to Italy is an island flap in a palate!

I warned:

Do not do the island flap pushback before 4 to 5 years, and only in cases with good mobility and about 1.5 cm. gap between velum and pharyngeal wall.

EVEN IN THE HORSE’S MOUTH

Closing the cleft palate in the horse has been difficult (Kendrick, 1950; Batstone, 1966; Stickle, Gable and Braden, 1973). In 1975 R. S. Jones, D. O. Maisels, J. J. De Geurs and B. B. J. Lovius of Liverpool described cleft palate closure in three horses, facilitating the difficult exposure by mandibular symphysiotomy. They noted:

While simple paring and suturing will enable one to close clefts affecting the soft palate only, more extensive defects reaching forward into the hard palate demand more sophisticated procedures. These include raising flaps of mucoperiosteum from the hard palate to permit closure of the oral layer, while repair of the nasal layer requires mobilization of the mucosa, use of flaps from the vomer and occasionally even island flaps of oral mucosa as well (Millard 1962).
ALSO USEFUL AGAINST FISTULAE

In 1972 S. Takahashi of Tokyo sent photographic records of his use of the island flap for an oroantral fistula, showing: (1) closure of the antral side, (2) dissection of bundle, (3) completed operation, (4) result two months postoperatively.

In 1977 Takahashi wrote:

The island flap of the palate is still used to close oroantral perforations in our clinic. Raw surface in the hard palate is smaller with the island flap than with the usual palatal flap method and the folding occurs at the lesser curvature of the palatal flap.

In one of his sections in the 1973 German book of clefts edited by Schuchardt, Steinhardt and Schwenzer, Werner Widmaier of Stuttgart presented diagrams of the use of the mucoperiosteal island flap by forward advancement for closure of an anterior central hard palate fistula. There was minimal local tissue available otherwise for occluding this hole. Excellent photographs of a representative case demonstrated the effectiveness of the principle clearly.
In 1974 in the *British Journal of Plastic Surgery*, D. C. Herbert of Liverpool presented a variation in the use of the island flap for the closure of a hard palate fistula measuring 3.0 cm. by 2.3 cm. An island flap was taken from the right side and an oblique furrow made on its buccal aspect in order to present a raw surface to the vomer. A mucoperiosteal flap from the left side was used for the second-layer closure.

Herbert noted:

It might be possible to close even larger fistulas by using mucoperiosteal island flaps from both sides of the fistula and placing them side by side in the nasal layer. Cover could be provided by a free graft or a tongue flap. In this way, it might be possible to close fistulas which involve as much as two-thirds of the area of the hard palate.

In 1974 in the *British Journal of Oral Surgery*, D. Henderson of Canniesburn Hospital, Glasgow, designed an interesting modification in the use of the island flap principle in closure of lateral oroantral fistulae.
If the fistula is placed further laterally, and therefore at a higher level in the buccal sulcus, the margin of the island will no longer coincide with the periphery of the excised fistula, and an intermediate bridge of mucosa will remain along the alveolar crest. In these circumstances, excision of the intervening bridge would result in unnecessary loss of tissue. Instead, it should be raised from the underlying bone (if necessary, a little of the bone itself can be removed) to allow the island to be tunnelled underneath the mucoperiosteum to appear in the buccal defect. Provided the original distal margin of the flap is undermined, the total periphery of the island can be gently drawn underneath the mucosal bridge and sutured round its circumference to the edges of the fistula. The bony funnel in which the greater palatine artery lies after its emergence from the greater palatine foramen may be enlarged laterally to increase the degree of upward and lateral movement of the nutrient pedicle, thus avoiding any threatening tension on the artery. This technique makes available a considerable hunk of well-nourished tissue for closure of the fistula without reducing the depth of the sulcus and without creating a bulge of soft tissue in the palate. After secondary epithelialization of the palatal defect, a very normal denture-bearing area is obtained. This may commend the method in some edentulous cases in preference to the traditional buccal advancement and palatal rotational flaps.

FIRST PALATE ISLAND FLAP

Now comes the punch line! In 1977 a reference by Worthington called attention to a German paper which, after translation, revealed that as early as 1939 Fritz von Brosch of Hamburg, a general surgeon who had become interested in oral surgery, described a mucoperiosteal flap based on a greater palatine neurovascular bundle, which he used for oral closure of "perforations in the area of alveolar +5 and +6." This flap was condemned by Fröhlich in 1948 because of "extensive isolation of the vessels" with "the peril of thrombosis and the danger of manipulation" only withstood by larger vessels. Such criticism frightened other surgeons away from accepting the method. In 1950 Brosch defended this mobilized palatal flap based on a neurovascular pedicle, explaining that it could rotate in a wide radius without the usual kinks and wrinkles of a standard mucoperiosteal flap and could be stretched to greater length to reach alveolar fistulae.
inaccessible to the standard flap. It is true that Brosch did not
turn the flap over or use it for nasal lengthening in cleft palate,
but he was the first to use the island flap principle in the palate
area!
34. Use of the Palatal Island Flap for Ablative and Other Defects

The principle of the island flap makes available large areas of mucoperiosteum supplied by a neurovascular bundle which can reach the distance of its pedicle a 360-degree area around the particular posterior palatine foramen. The donor area is backed by bone and, after full growth of the maxilla, will heal quickly without deformity. Thus the island flap is an epithelium-covered, independent, durable, maneuverable unit with many possible uses. In 1963 I predicted that this flap would be useful in soft palate defects following tumor ablation and trauma and in 1966 reported two cases briefly. One was a patient in whom a posterior pharyngeal and tonsillar resection for cancer treated with a skin graft had produced a pocket in the tonsil area that consistently trapped food. After excision of the graft, an island flap was fitted to fill out the pocket without further difficulties. In another case of subtotal soft palate excision, a wide pharyngeal flap based superiorly was covered with a large island flap to achieve partial soft palate reconstruction and improved velopharyngeal closure.

In 1969 Maisels reported a case of partial maxillectomy for squamous cell carcinoma arising on the alveolus which resulted in a bony defect in the nostril floor. At the time of ablation, a mucoperiosteal island flap carried on the contralateral greater palatine vessels was used to repair the defect.
In 1974 in the *British Journal of Oral Surgery* D. Henderson of Glasgow, Scotland, noted that oroantral fistulae following maxillary excision of relatively benign lesions can result in major defects requiring a permanent prosthesis or extensive reconstructive surgery. He designed a two-stage repair utilizing a palatal island flap, noting that at the second stage, reexamination of the operative area to exclude recurrence was possible. He advised against this procedure for cases of malignancy or palatal salivary tumors known to invade bone or bony canals.

Following resection of the lesion, Henderson developed island flap A and, when possible, removed the anterolateral wall of the greater palatine foramen for extra freedom. He inverted the island with the epithelium facing the antrum and advanced buccal mucosa by incisions (broken lines) to cover as much of the island as possible. No attempt was made to advance these flaps to the midline to close the medial fistula. Six months later, the second
stage involved two-layer advancement of both edges with closure of the nasal layer by direct suture. Closure of the oral layer by a longitudinal relaxing incision in the mucoperiosteum parallel to the medial edge of the fistula created a bipedicle bridge flap for advancement to the buccal flap. Other small buccal flaps were suggested, if necessary, for the anterior end of the hole.

Another case was reported of a 12-year-old female requiring a partial maxillectomy for an odontogenic fibromyxoma in 1969. Reconstruction by the two-stage island flap method followed with a partial denture which was still serving well after five years.

In 1974, in the *British Journal of Oral Surgery*, Philip Worthington of North Wales Hospital noted:

Some 55 percent of intraoral salivary tumours occur in the palate and of these some 55 percent are pleomorphic adenomata, 25-30 percent are muco-epidermoid tumours, 15-25 percent are cylindromata and 5 percent are carcinoma.

It is difficult to assess the limits of the pleomorphic adenomas, and they have a tendency to recur. On this basis it was suggested that a wide resection with fenestration of the palate may be necessary. Repair of the defect in six cases by Worthington involved an unlined oval island flap, based on the neurovascular bundle of the opposite side and transposed over the full-thickness palate fistula. He noted:

This application of the island flap may serve to remind us of its great versatility.

He then admitted, rightly:
Criticisms of the use of an unlined flap are likely to be directed along the following lines: first, the raw upper surface may be the site of undesirable crusting with an unpleasant odor. Secondly, the flap is likely to contract, causing velopharyngeal incompetence. Thirdly, the flap may fibrose and render the palate relatively immobile, interfering with normal function.

**OTHER PERSONAL CASES**

Here are four other interesting cases of mine, published in the *British Journal of Plastic Surgery*, in which the island flap has been useful.

**Squamous cell carcinoma**

A 46-year-old black male, with a lesion of his soft palate and no evidence of local node involvement, had biopsy which revealed well-differentiated squamous cell carcinoma. Local excision involved resection of the entire soft palate to its junction with the hard palate, including the tonsillar pillars on both sides. After healing, the patient experienced difficulty in taking liquids and soft foods, and his speech was unintelligible.

Six months later the reconstructive plan was designed, and resident H. A. Seider turned forward a wide, superiorly based pharyngeal flap and sutured it to the posterior edge of the palate. A mucoperiosteal island flap based on the left neurovascular bundle was lifted off the left hard palate and passed through a mucosal incision, connecting the donor area to the recipient site...
to overlap the underbelly of the pharyngeal flap. The reconstruction healed uneventfully, and six weeks later the patient was having no difficulty with liquids or soft food and his speech was near normal and improving.

Acinic cell carcinoma

Nasse in 1901 was the first to describe acinic cell tumors, and Buxton in 1953 pointed out that these tumors can run a clinically malignant course with recurrence and metastasis. A rare acinic cell carcinoma of the soft palate in a 35-year-old white male (1) was reported which required radical resection of almost the entire left soft palate (Deutsch) (2). Healing produced a fistula, contractures and velopharyngeal incompetence with a speech-crippling effect not unlike that of an unoperated cleft palate (3). As the patient was a prominent criminal lawyer, his speech defect seriously impaired his performance in court and his livelihood. Reconstruction was mandatory.
Ten months after ablation, scar excisions and release of contracture repositioned normal tissues (4 and 5). A right mucoperiosteal flap (B) was used to fill the nasal lining defect along the posterior edge of the hard palate. A superiorly based pharyngeal flap (E) was attached to the island flap and to the posterior edge of the palate defect to complete the reconstruction on the nasal side (6). Then a large mucoperiosteal island flap from the left side (C) was swung around for oral cover of the raw underbelly of the pharyngeal flap (7).

Speech improvement was almost instantaneous (one week). By one month, because of his effort and study to adjust to the defect prior to reconstruction, the patient felt that his speech was better than before the ablation. It is three years since reconstruction, and all is well.
Stenosis following T & A

A 13-year-old boy, six years after a tonsillectomy and adenoidectomy, presented a complete stenosis of the nasopharynx. One attempt at surgical correction had been unsuccessful.

On examination, the entire posterior edge of the soft palate was seen to be plastered with scar to the pharynx, showing a dimpling (arrow) but complete obliteration of the nasal airway. The patient had great difficulty when eating and breathing at the same time.

During surgery, the adhesion between velum and pharynx was divided, leaving large raw areas on the upper surface of the posterior soft palate and on the posterior pharyngeal wall. A flap of lateral pharyngeal mucosa was transposed to close the pharyngeal defect. Then the soft palate was split down the midline, and a left mucoperiosteal island flap was dissected free and passed through to cover the raw superior surface of the posterior soft palate. The velum was resutured, and healing was uneventful. With the nasopharyngeal aperture completely lined, it has remained patent four years with normal speech. The patient can breathe through his nose with mouth closed and eat and breathe simultaneously without difficulty.

Choanal atresia

At the University of the West Indies, Kingston, a 14-year-old Jamaican girl with a choanal atresia was treated by Kenneth McNeill, who cut the palatal mucosa with a through-and-through punch.
through incision just back of the posterior edge of the hard palate. This gave exposure so that he could remove the bony obstruction with a chisel and mallet to open the airway from the nose to the pharynx.

The raw tunnel thus created, since it was without lining, was destined soon to close off. A slender right mucoperiosteal island flap was dissected free on its neurovascular bundle. Following ostectomy of the posterior wall of the greater palatine foramen, the island flap was slid along the bottom of the tunnel and sutured in place. This supplied an epithelial strip to maintain a patent nasal airway until complete epithelialization of the tunnel could be achieved similar in principle to the skin strip used by Denis Browne to create a urethra. Recently the patient was examined and revealed patency of the nasal airway with normal breathing eight years after the reconstruction.
35. Long-Term Evaluation of the Palatal Island Flap

TEN-YEAR EVALUATION IN MIAMI

AFTER our 10 years' experience, a report in Plastic and Reconstructive Surgery on the palatal island flap noted in 1970 that, although 200 island flaps had been used for palate lengthening in all types of cleft problems—primary and secondary—only 73 cases could be reexamined for evaluation. This low percentage was due to the often transient population of South Florida and to the inaccessibility of many of the children in the Bahamas and the West Indies. The results, although not mathematically exact, did serve to give a general impression. With Jack Bensen as the constant speech analyst, J. H. F. Batstone of Oxford (1966) and M. H. Heycock of Great Ormond Street Hospital for Sick Children (1969) carried out the clinical assessments. Both Batstone and Heycock were from British units which did not employ the island flap; neither had been involved previously in the cases studied. They were interested in but had no loyalty to this method. Many patients tested by Batstone were retested by Heycock, without knowledge of the outcome of the previous examination—but the results showed no significant difference. During the assessment, attention was directed to the palatal mobility, length, speech results and fistulae.

Mobility

A control survey of speakers without clefts revealed that normal mobility ranged from moderate to excellent with a fairly even scatter. Out of 24 patients with complete clefts, 20 had mobility
within normal range and three had fair movement. In those with incomplete clefts, 25 out of 30 were within normal limits. Thus about 85 percent had satisfactory mobility, a result suggesting that, unlike the synechia of a pharyngeal flap which reduces palatal mobility, the island flap allows normal movement.

**Length**

Palate length in normal patients varied from moderate to very long. In 46 out of 59, palate length was within normal limits. Thus 78 percent had satisfactory length. Short results in complete clefts were found to be associated with a general lack of tissue, as seen in some bilateral and severe unilateral clefts. Short results in incomplete clefts again seemed to be associated with gross lack of tissue, as in the horseshoe-shaped palate with a wide cleft and short palatal elements. Two failures in submucous clefts occurred in short palates operated on at 9 and 11 years of age.

The occasional failure in lengthening that occurred with no apparent cause has to be blamed on too small an island flap or subsequent necrosis and contracture.

Of course, length and mobility are interrelated; often good activity will make up for some palatal shortness and vice versa.

**Speech Results**

Speech was assessed strictly and dispassionately. Nasal escape was determined primarily by its audibility but confirmed by the misting of a mirror held under the nose while a prolonged s and e were pronounced. The mirror was marked in accordance with the judgment of the speech pathologist.

Speech was graded "normal," "slight nasal escape," "moderate nasal escape," and "gross nasal escape." "Normal" meant absolutely normal. "Slight nasal escape" was very slight and probably would be passed as normal by most surgeons (and certainly by the lay public). "Moderate" and "gross" nasal escape indicated degrees of abnormality (Table 1).

Patients with normal speech or slight nasal escape were considered to have satisfactory results (approximately 80 percent). Those with moderate or gross nasal escape were considered to be failures.
Table 1. Type of Cleft and Speech Result (from Primary Operations)

<table>
<thead>
<tr>
<th>Cleft Type</th>
<th>Normal Speech</th>
<th>Slight Nasal Escape</th>
<th>Moderate Nasal Escape</th>
<th>Gross Nasal Escape</th>
<th>Mentally Retarded</th>
<th>Satisfactory Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete</td>
<td>10</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>18 out of 24</td>
</tr>
<tr>
<td>Incomplete</td>
<td>18</td>
<td>7</td>
<td>4</td>
<td>—</td>
<td>1</td>
<td>25 out of 30</td>
</tr>
<tr>
<td>Submucous</td>
<td>2</td>
<td>2</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>4 out of 5</td>
</tr>
</tbody>
</table>

FAILURES IN COMPLETE CLEFTS.
1. A bilateral cleft in which we closed the soft palate only, and left the anterior palate open for premaxillary retropositioning.
2. A mentally retarded patient.
3. A small island flap early in the series, with a particularly wide cleft.
4. Repaired at 10 years of age.
5. Repaired at 12 years of age.
6. Anterior palate closed elsewhere previously.

FAILURES IN INCOMPLETE CLEFTS.
1. A mentally retarded patient.
2. A horseshoe-shaped cleft.
3. An extremely short palate initially.
4. A cleft of the soft palate in a 2½-year-old child.

FAILURE IN A SUBMUCOUS CLEFT. This was a girl of 9. She had had normal speech until her tonsils were removed at the age of 4. She then developed a severe speech problem, which was not helped by the island flap operation.

In summary, the more mobile palates seem to produce better speech—but there was one child with an immobile palate which, although short, allowed only slight nasal escape (Table 2).

In this study it was obvious that the longer the palate, the better the speech results. As in normal people, there were some patients who sometimes made up for deficiencies in palatal length by extreme mobility of the pharynx (Table 3).
Table 2. Mobility of Palate and Speech Results

<table>
<thead>
<tr>
<th>Mobility</th>
<th>Normal Speech</th>
<th>Slight Nasal Escape</th>
<th>Moderate Nasal Escape</th>
<th>Gross Nasal Escape</th>
<th>Mentally Retarded</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMPLETE CLEFTS, CLOSED PRIMARILY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>—</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Moderate</td>
<td>—</td>
<td>1</td>
<td>1</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Good</td>
<td>8</td>
<td>5</td>
<td>1</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Excellent</td>
<td>1</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>INCOMPLETE CLEFTS, CLOSED PRIMARILY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Nil</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Slight</td>
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<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Fair</td>
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<td>—</td>
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</table>

Table 3. Length of Palate and Speech Results

<table>
<thead>
<tr>
<th>Length</th>
<th>Normal Speech</th>
<th>Slight Nasal Escape</th>
<th>Moderate Nasal Escape</th>
<th>Gross Nasal Escape</th>
<th>Mentally Retarded</th>
<th>Satisfactory Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMPLETE CLEFTS, CLOSED PRIMARILY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very short</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Short</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>—</td>
<td>3 out of 5</td>
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<td>Moderate</td>
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<td>1</td>
<td>5 out of 10</td>
</tr>
<tr>
<td>Long</td>
<td>5</td>
<td>4</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>9 out of 9</td>
</tr>
<tr>
<td>Very long</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1 out of 1</td>
</tr>
<tr>
<td><strong>INCOMPLETE CLEFTS, CLOSED PRIMARILY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very short</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1 out of 1</td>
</tr>
<tr>
<td>Short</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>4 out of 6</td>
</tr>
<tr>
<td>Moderate</td>
<td>5</td>
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<td>—</td>
<td>7 out of 9</td>
</tr>
<tr>
<td>Long</td>
<td>11</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>12 out of 13</td>
</tr>
<tr>
<td>Very long</td>
<td>1</td>
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<td>—</td>
<td>—</td>
<td>1 out of 1</td>
</tr>
</tbody>
</table>

**DUKE EVALUATION**

In 1969, in the *Cleft Palate Journal*, Georgiade, Mladick, Thorne and Massengill evaluated their 54 island flap cases. They noted that the majority of the patients were too young to permit standard cleft palate speech studies. Cinefluorographic tracings of the distance from velum to pharyngeal wall during phonation of
i were obtained in 16 of the older patients. Three to six months after surgery, six patients (38 percent) had complete velopharyngeal closure, and 10 had a gap during phonation. Both fine braided wire markers placed in the midline on the anterior and posterior edges of the island during surgery were retained in 14 patients. Measurements by x-ray, between markers or the widest part of the island, showed that the amount of nasal lengthening shortly after surgery averaged 16 mm. Measurements taken three months later showed a mean decrease of 4 mm. or 25 percent shrinkage. There was a 4 percent incidence of postoperative fistulae. The mobility of the velum was reported to be impressive even in the very early postoperative examinations, and the asymmetry was not significant. In an observation that proved to be a prophecy, the authors noted:

The operation denudes more bone than the usual pushback, which may be detrimental to palatal growth. It does not appear to have the added disadvantage of the Cronin procedure in which both the nasal and palatal mucosa are elevated, thus denuding portions of the palatal bones on both sides.

They concluded:

In our opinion, the procedure is good technically. However, it must be used with discretion for older patients and patients with wide cleft palates.

In 1977 Nick Georgiade sent this follow-up:

Ray Massengill, our Speech Pathologist, feels the results are about what we stated in the 1969 article. Also, there is no appreciable difference in the speech in these patients who have had the Island Flap and those who have not, in our series of approximately 80 patients.

MONTEFIORE EVALUATION

In 1975, in the Cleft Palate Journal, Lewin, Heller and Kojak, of Montefiore Hospital, the Bronx, New York, studied their results with the island flap pushback procedure. They summarized:

Twenty-four patients were evaluated for voice quality after primary palatal repair by the Millard island flap procedure. In patients with overt cleft palate, acceptable speech was obtained in 71 percent. In patients with velopharyngeal insufficiency without an overt cleft, the success rate was 60
percent. Although we consider this method reliable and useful, we have no reason to believe that it offers substantial advantages over other established procedures. We suggest that the main reason for our failures to achieve velopharyngeal competence and acceptable voice quality after a repair is the inherent hypoplasia of palatal musculature.

A fascinating observation was made by this group:

Examining our lateral cephalograms we noted an interesting finding regarding the configuration of the palate after the Millard island flap operation. In a few patients, in addition to the "knee" (levator prominence), we noted on phonation another elevation anterior to the "knee." This double hump, which we refer to as a "camelback" appearance, probably corresponds to the observation of Pigott et al. and Millard of buckling and puckering of the flap on the nasal side. However, some patients with the "camelback" palate had adequate voice quality, and we could show no correlation between this radiologic finding and voice quality.

Here is a "camelback" palate with a voice quality rating of 2.3 shown at rest and phonating "Eeee ... ."

Another "camel" with a voice quality rating of 1.0 at rest and phonating "Eeee ... ."
Little did it ever occur to me that I have been propagating two-humped "horses" as referred to in the Preface of Volume I.

HOPKINS EVALUATION

In 1976 Luce, McClinton and Hoopes reviewed patients of the Facial Rehabilitation Clinic of the Johns Hopkins Hospital who had had a primary repair of a cleft palate by the unilateral small elliptical island flap technique performed between January 1, 1965, and December 31, 1971. They summarized this seven-year follow-up.

We analyzed all 104 island flap pushback palatal repairs done through our Facial Rehabilitation Clinic in the period from 1965 to 1971. The results were compared to those in a group of 109 standard pushback repairs.

The island flap group had a higher incidence of operative complications, of velopharyngeal insufficiency, and of secondary procedures to correct the latter. (The differences between the two groups were not statistically significant, however.)

In this group of patients the island flap repair offered no particular advantage over the V-Y or the Dorrance push-back; in fact, it may have been deleterious.

A hypothetical explanation for these results is offered, based on possible continuing osteogenesis by the transplanted mucoperiosteum, to produce an inflexible and poorly functioning velum.

They did admit:

Thus, the final result of excellent or good speech was obtained in almost 85 percent of the island flap group. Unfortunately, the retrieval of that final result necessitated frequent reoperation, rather than less frequent reoperation as had been anticipated by the early devotees of this procedure.

I cannot imagine why so many operations were required. An occasional pharyngeal flap should solve most residual problems. It was a bit more encouraging to hear personally from John Hoopes in 1977:

It has been my feeling that the island flap pushback palatoplasty is the only procedure which results in significant retro-displacement of the levator sling. I have, therefore, in my personal series utilized (almost exclusively) the island flap pushback for repair of cleft palate. Needless to say, I was distressed by the data in the recent paper by Drs. Luce, McClinton and
myself. It is imperative, now, that I extract from that data those island flap pushback procedures performed only by myself—in that I, personally, have had no postoperative fistulae, and my patients have not (inordinately) required secondary pharyngeal flaps. In spite of the data, I continue to utilize the island flap pushback—simply because I have no procedure available which significantly retro-displaces the levator sling.

BUTTERWORTH EVALUATION

In 1975 Blocksma, Leuz and Mellerstig of Grand Rapids, Michigan, reechoed the plea against early mucoperiosteal flap dissections:

We analyzed all the cleft palate surgery performed from 1963 to 1973 in Butterworth Hospital. . . . Evidences of long-term complications in our own patients, and those of others, who had been repaired by the traditional mucoperiosteal flap techniques led us early to the conclusion that such operations as the Dorrance pushback, the Wardill V-Y pushback, the Millard island flap and the typical Von Langenbeck operation were all to some extent implicated in the gradual development of facial deformity. Many patients who had had an early mucoperiosteal flap closure looked excellent at the age of 5 years, but exhibited evidence of serious maxillary growth arrest at the age of 15 years.

Blocksma leveled a direct attack on the island flap, but from his description it is obvious that he was still using the original elliptical island instead of the larger modern ones.

Secondary pharyngeal flaps were required in as many patients after radical palate lengthening procedures as after our conservative closures.

In all likelihood our study included a disproportionately large number of older patients who had had complications after repeated radical closures. It is significant that 22 of our 43 patients who had been treated by the Millard island-flap procedure subsequently required a pharyngeal flap (51 percent); 90 percent of the 43 showed a significant contracture of the alveolar arch. We concluded that this procedure provides considerable additional tissue on the oral side, and a dubious increase in length on the nasal side, at a very high price in subsequent deformity.
MY EVALUATION AFTER THE FIRST 19 YEARS

At the time of its conception, it was hoped that the island flap for lengthening nasal lining would be a universal panacea for all palate problems. Nineteen years and about 300 island flaps later, it has been found that such is not the case. With the aid of Walter R. Mullin, our most recent study of 141 available island flap pushback cases revealed that 12 had required later addition of a pharyngeal flap (8.5 percent). Among these 12, two were mentally retarded, one had multiple congenital anomalies including lack of half of the soft palate (A), one had a wide cleft of the soft palate (B), and one was a CPI with a deep pharynx who developed severe nasal escape after a T & A. A pushback with an island flap was followed in two years with a pharyngeal flap, and three years later with lateral pharyngeal flaps to reduce lateral escape and to produce normal speech. Another had a short, scarred secondary palate with a posterior gap of 2 to 3 cm. (C).

Most of these cases received the pushback, with an island flap as a secondary procedure, later than the ideal age, varying from 6 to 26 years. Two were primary island flap pushback cases at 16 months of age (1962) and 20 months (1961), and each of these had a horseshoe-shaped deformity with severe deficiency of tissue of the soft palate musculature. Continued nasal emission or development of emission after T & A precipitated the addition of a pharyngeal flap one to eight years after the pushback, with an average interval of 3.2 years.
Four more cases face the possibility of having a pharyngeal flap, which would make a total of 11.3 percent. These cases either had the pushback-island flap as a secondary procedure, resulting in more nearly normal speech which speech therapy is attempting to improve, or were early primary pushback-island flaps in clefts with severe deficiency of soft tissue musculature.

As in all plastic surgery, the choice of the case is important. The mucoperiosteal elliptical island based on one or, preferably, both posterior palatine neurovascular bundles can be turned over to supply as much as a 20 × 30 mm. (usually 12 × 30 mm.) stiff mucosal patch—to fill the nasal gap produced by the release and backward migration of the levator muscles and soft palate. There are limitations as to how much palate length this flap can achieve and how much flap some palates can spare.

When the island flap can be spared and the required lengthening does not exceed 12 mm., this procedure is ideal. It is physiological and it does not impede palate mobility while achieving permanent length. It is not effective in a paralyzed palate, but when scarring has produced some immobility the release can be dramatic.

Preservation of a triangle of mucoperiosteum anteriorly, as well as the adjunct of retropositioning and suturing the levator veli palatini muscles, is now included in the standard pushback-island flap procedure.

Berkowitz

Of course, the question of maxillary distortion always arises in any palate operation, but according to Berkowitz in 1970, the island flap was not causing more distortion than other methods when orthodontic correction had been carried out by the usual techniques, if indicated. Since then, however, there has been enough evidence of distortion following primary pushback with an island flap to cause Berkowitz to request postponement of this more radical surgery until age 3 to 5 years. As he noted at the end of his Chapter 4 in this volume:

An island flap will not cause palatal deformation if performed on a well-developed palate with adequate tissue and if the lateral incisions are made at least 5 mm. medial to the dentition.
Berkowitz has been following my cases with lateral cephalometric studies for many years. Here are some of his observations on the pushback with an island flap:

**Palate lengthening using the “island flap”**

1. **Congenital palatal incompetence (CPI)**
   - The failure of the velum to make contact with the retropharyngeal wall in CPI is usually due to an excessively deep pharyngeal space. Pre-surgical evaluation of the palatal tissue is crucial in determining the adequacy of the tissue for palatal lengthening. A ten-year monitoring of palatal development following the island flap led us to conclude that the least deleterious effect resulted when surgery was postponed until 5 years of age, when 80% of palatal growth was completed. The worst effect resulted when the island flap was used as a primary cleft closure procedure, and the lateral incisions were made close to the teeth.

2. **Isolated cleft palate**
   - **4 years** Preoperative evaluation: Short velum associated with a relatively deep pharyngeal space and a sparse adenoid mass.
   - **6 1/2 years** At rest. Velum lengthened by island flap.
   - **6 1/2 years** Vocalizing “Youuu. . . .”
     - Good elevation with a velopharyngeal gap of 5 mm.
     - Vocalizing “Sss.”
   - **7 1/2 years** The velum increased in A-P length and was able to make contact with the pharyngeal wall at the adenoid.

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7½ years The stretch reflex was still evident a year later. The functional velum appears to become thinner than when at rest. The lengthened velum remained the same length one year after surgery.

3. Submucous cleft palate

Cephalometric and model analysis associated with an island flap performed at 4½ years of age. Successful reduction of hypernasality.

3 years The velum is too short to function adequately within this pharyngeal architecture.

4½ years After the island flap procedure during vocalizing of "Youuu..." The velum elevates and makes contact with the adenoid.
6 years At 6 years, the velum lies on the dorsum of the tongue at rest. During function the velum makes good contact with the adenoid. Hypernasality was reduced postoperatively, and there was no change in velar function one and a half years postoperatively.

4. Failure of the "island flap" procedure
The velum did not reach the posterior pharyngeal wall during function. Postsurgical cephalometric examination revealed the failure of the velum to obturate the nasopharynx during function. One cannot presume that all velar pushbacks will function adequately.

In this instance a pharyngeal flap was performed to further improve airflow control. The need to perform a pharyngeal flap should not necessarily condemn this palatal lengthening procedure, for there are instances when a pharyngeal flap can also fail in its purpose. Further research is necessary to relate the condition of the palate, the depth of the pharynx and velar length to the surgical procedure of choice.

MODERN PLAN
I now close the soft palate at the time of the lip adhesion or definite closure, and the hard palate when the operation can be accomplished without more than lateral relaxing incisions and moderate undermining at 18 months. Then I wait to see how speech will develop. In the 25 to 30 percent of patients with velopharyngeal incompetence, an island flap pushback at 4 to 5 years can be carried out if the velopharyngeal gap is no more than 1.5 cm. and the mobility of the palate is good. If not, a pharyn-
geal flap or an island combined with a pharyngeal flap may be indicated. In fact, in patients with a short velum, reasonable mobility and a large velopharyngeal gap, I have come to employ the combination of an island flap in a pushback to enable the lengthened palate to make good use of its muscle action. Moreover, I add a superiorly based pharyngeal flap not only for reduction of the large space and the obturator effect but to act as a high, resting, unrestricted suspensory tether to hold the velum backward and elevated, to reduce the velar excursion necessary for functional pharyngeal closure. The pharyngeal flap can be as large as the cleft tissue deficiency requires or as small as a Stellmach adhesion. The reduction in the amount of lift the palatal muscles must continuously and rapidly achieve not only increases efficiency but reduces fatigability. This combination wins in most cases, even in the face of large tissue deficiencies. Thus, in the first three months of 1978, the simultaneous combination of a pushback with an island flap and some type of pharyngeal flap has been used in five out of the last 10 secondary cases, with an age variation of 9, 14, 17, 19 and 25 years. For a more detailed evaluation of an evolutionary series of palatal closures including island flaps see Chapter 46.
IV. Pharyngeal Flap
Attachment to the Velum


Introduction to Part IV

A gloomy prediction in '33

As early as 1933 Dorrance predicted a dismal future for the use of a pharyngeal flap in the correction of the split palate:

[Although] ingenious . . . this operation . . . will not stand the test of time, despite the excellent results obtained by Rosenthal.

He complained that it diminished the lumen of the pharynx, produced scar and interfered with the palatopharyngeal muscle function, giving these reasons:

The procedure does not attempt to establish the desired "palatopharyngeal-sphincter." If the pharyngeal flap includes a portion of the superior constrictor muscle, the pterygopharyngeus portion of this muscle becomes destroyed and its atrophy is inevitable. Staphylopharyngorrhaphy establishes "stomatolalia," interferes with normal ventilation of the Eustachian tubes, and favors the accumulation of nasal secretions.

P. P. F. epidemic continues in '80

In spite of the apparent unphysiological nature of a pharyngeal synechia to the palate, there has continued to be a worldwide epidemic of flaps. They have been used in such a variety of ways that it takes several chapters to trace the progression.
36. Velopharyngeal Synechiae with Various Pharyngeal Flaps

FIRST AN ADHESION

In 1865 the remarkable Gustav Passavant described his adhesion method to reduce the velopharyngeal aperture. Ideal position for the adhesion was noted, and it was strategically placed on the free border of the velum and the posterior pharyngeal wall. Equivalent areas, 8 lines long and 5 lines in depth, were denuded of epithelium. The velum was then attached to the pharynx with sutures, with what Passavant described as better results.

In 1979 Chinese Surgeon Song Ruyao advocated a "raise-up" adhesion similar to Passavant using an inverted T incision in the posterior pharyngeal wall to create triangular flaps for suturing to the nasal sides of the cleft velum during palate closure.

INFERIORLY BASED PHARYNGEAL FLAPS

From Stellmach’s scholarly research and translations of the original German, presented in Plastic and Reconstructive Surgery, 1972, revealing information has been provided on the earliest pharyngeal flaps.
Karl Wilhelm Ernst Joachim Schoenborn was a student under von Langenbeck at the University of Berlin and later was appointed professor and chief of surgery at the University of Königsberg. In 1876 he described a flap as it is used today. He wrote with modesty, giving credit to those before him but demonstrating his own remarkable clairvoyance:

I believe it is a known fact among most surgeons that healing of the congenital cleft palate can be achieved, with a high degree of certainty, by the uranoplasty introduced by von Langenbeck and by a staphylorrhaphy. However, after even the most successful operation the speech of these patients leaves much to be desired; there is severe nasality.

Passavant pointed out that the patient retains a nasal tone, despite the good healing achieved, because the newly formed soft palate is too short to accomplish velopharyngeal closure.

Please allow me to bring a new surgical method to your critical attention. This consists of incorporating a flap, taken from the posterior pharyngeal wall, between the two halves of the soft palate.

About 4 years ago, as I was discussing with my friend and colleague Trendelenburg the possibility of closing an abnormally wide cleft palate... he advanced the idea that it might be possible to join a flap from the posterior pharyngeal wall to the soft palate. If I remember correctly, he also made some important attempts on human bodies and animals; however, the operations appeared to be very difficult and, as far as I know, there were no further attempts.

I performed this operation on a female patient on July 2, 1874. This patient, Emma Kollecker, aged 17, had a congenital (unoperated) cleft of the hard and soft palate.

After induction of general anesthesia... I made rim incisions along the cleft borders. With a long scalpel... I outlined a flap about two cm long and 4 to 5 cm wide, with its long axis vertically and its base caudally, from the posterior wall of the pharynx.

The incision was carried through the mucosa and underlying muscles... (Particular attention must be paid to keeping the scalpel within the loose areolar tissue beneath the muscle, so that no part of the flap is thinner than the other.) Next, I detached the mucoperiosteal layer of the hard palate enough so that it and the soft palate were sufficiently mobile. Then I trimmed the edges of the flap so that it was in a triangular form, with the tip at the upper end. This was sutured then between the dissected two halves of the velum. The cleft in the hard palate was closed with 3 additional sutures.

Schoenborn admitted partial separation of the flap on the left side and opening in the hard palate, which was corrected with a von Langenbeck operation.

Schoenborn continued:
The result of the operation, as far as improvement of speech was concerned, was very important. Immediately after healing had taken place, the patient's speech was absolutely clear and easily understandable to everyone. The nasality had not disappeared completely, but it diminished week to week as the patient learned, by speaking, to close both side openings through the activity of the pharyngeal muscles. These muscles being on the sides of the pharyngeal flap facilitate closing the communication between the nasal and oral cavity.

The patient had no difficulties in swallowing, nor in breathing through her nose. . . . Until this patient, I had not seen such a remarkable improvement in speech immediately after healing took place.

Ten years later, in 1886, Schoenborn reported progress with his flap:

I have now done the staphyloplasty on 20 patients. Of these, one died of septic pneumonia; in 3 other cases, the transplanted flaps became necrotic. Healing was achieved in 16 cases; in two of them it was limited to one side of the flap, but after a second operation the other side also healed. In the remaining 14 cases, healing was uneventful.

Rosenthal

In 1924 Wolfgang Rosenthal of Berlin revived Schoenborn's pharyngeal flap based inferiorly, combining it with a modified von Langenbeck palate closure for all cases involving the hard and soft palate. This combined procedure was done in one sitting and thus is the first use of the pharyngeal flap primarily in the cleft closure. Like Halle and Ernst, Rosenthal carried out lateral relaxing incisions close to the alveolar ridge and back along the pterygomandibular ligament to within 1 cm. of the last mandibular molar tooth. Rosenthal claimed:

You get perfect or almost perfect speech results if you combine a Langenbeck operation with a pharyngoplasty during the same procedure.

At the First International Congress held in Stockholm in 1955, Rosenthal reminisced:

When I performed a velopharyngoplasty for the first time, my reasons were less mechanical ones. At this time (1915–1916), I was occupied with an investigation of the muscular neurotization. A student of medicine with a completely mutilated velum was sent to me from Leipzig. The young man
spoke indistinctly and, therefore, had been dissuaded from his studies. His velum was totally paralyzed but the posterior pharyngeal wall seemed to be innervated. I took a muscular-mucous flap from the pharynx in order to obtain a muscular neurotization of the immobile velum parts. The success obtained was an astonishing one. The student, today, is an experienced physician at Zwickau-Saxony. He speaks normally.

Encouraged by this, I applied that method not only in cases of velum shortening but also in two cases of velum paralysis remaining after diphtheria. Time of operation: not before the age of 12 years. . . . Closure of the pharyngeal defect by catgut sutures is necessary.

Wolfgang Rosenthal was as famous a musician and singer as he was a surgeon. He sang under many well-known conductors, such as Furtwängler, Vihirch, and Bruno Walter. His friend Trauner described him as

serene, open-hearted, full of wit and a true artist.

R. Meyer of Lausanne, recalling his charm, wrote:

He was known as the best ladies' speaker at congresses. However, once in a speech, he declared that man is more beautiful than woman and that this fact is well illustrated by the German language since we say: mmmm! aaaa! nnnn! = mann . . . and on the other hand: wwww! eeee! iii! b = weib.

In Bratislava in 1965 I rode in a car partway with Rosenthal and a group of East German plastic surgeons on their way back to their sector and remember him clearly: handsome, with chiseled features, white hair and a gracious smile. To add to his distinctions, he once operated on a lip cleft in a lion cub.

Rosenthal had to turn a charming old castle in the village of Thallwitz into a maxillofacial surgery hospital, and here it is said he operated on 30,000 primary clefts coming from Germany and Czechoslovakia. It is sad that this noble surgeon was never allowed to have his own proper clinic only because he was supposed to have had a Jewish great-grandfather. The irony is even greater because his great-grandmother confessed on her deathbed that her first son, Wolfgang's grandfather, was actually the son of a young count Schoenborn whom she had known while on duty in a castle in Poland. Fate played a second Schoenborn's trick on him, for his pharyngoplasty eventually was called the Schoenborn-Rosenthal flap, but alas, for an entirely different Schoenborn.

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In 1951 Dunn noted that patients with a pharyngeal flap required less speech therapy than those with other repairs.

In 1972 Poul Fogh-Andersen of Copenhagen wrote of his inferiorly based pharyngeal flap attached to the mid-posterior oral surface of the velum:

As you possibly know, I was the first to "introduce" the pharyngeal flap operation in Scandinavia (1953) . . . In England, it seemed to be nearly unknown, even in Basingstoke, at the time I worked with the problem—as will appear from the enclosed copy of Gillies' letter from 1952.

Gillies' letter read:

I have not really enough experience of the pharyngeal flap operation to state that the speech results are worthy of the effort. I think they should be.

Dingman

In 1963, at the Third International Congress in Washington, D.C., Reed O. Dingman, W. C. Grabb and H. H. Bloomer of the University of Michigan reported dissections of 25 sagittally cut human heads, demonstrating:

The circular fibers of the superior constrictor muscle can be identified beneath the mucosa of the posterior pharynx . . . [and extend] cephalad to the level of the junction of the first cervical vertebra and the basilar portion of the occipital bone . . .

The posterior surface of the superior constrictor muscle is intimately related to a thin discrete buccopharyngeal fascia. The plane dorsal to this buccopharyngeal fascia is the retropharyngeal space which contains loose areolar tissue and separates the structures of the pharynx anteriorly from the prevertebral muscles and fascia immediately posteriorly. This loose areolar plane permits ready elevation of a pharyngeal flap . . .

The internal carotid artery, with the cervical sympathetic nerves on its medial aspect, was identified in the dissections. In the adult cadavers, the distance from the lateral incisions of the pharyngeal flap to the internal carotid artery was measured to be between 1 and 1.5 cm.

In these sagittally cut sections, a definite concavity of the posterior pharynx above the level of the second cervical vertebra was readily apparent. This concavity begins at the upper edge of the second cervical vertebra and deepens gradually over the first cervical vertebra to reach its deepest point at the lower aspect of the basilar portion of the occipital bone.
They described their operative technique for an inferiorly based pharyngeal flap:

The lateral incisions are placed so as to include almost the entire width of the posterior pharynx in the flap. The depth of the incisions is to the shiny white tendon of the longus capitus muscle. The flap is undermined with right angle scissors. . . . The flap may include a portion of adenoid tissue. . . .

After undermining the lateral pharynx with right angle scissors, the posterior pharyngeal donor site is closed with figure-of-eight No. 3-0 chromic catgut sutures. . . .

The distal end of the pharyngeal flap is held on the oral surface of the soft palate under minimal tension in order to outline the size of the soft palate flap. This flap of mucosa and submucosa based on the posterior edge of the palate is raised by sharp dissection. The two flaps are then sutured back to back.

They reported that, out of 50 posterior pharyngeal flap patients over one year after surgery, 21 had satisfactory speech records.
which revealed improvement in articulation with few exceptions and invariably lessened hypernasality. Only seven were in the acceptable range, but all had shifted from moderately severe hypernasality to very mild hypernasality.

Huffstadt
A. J. C. Huffstadt of the Netherlands, besides doing a bit of bloodhound breeding and keeping three-fourths of an acre of pink peonies, mauve dahlias and apple trees, devotes the majority of his time to surgery. In 1970, in the British Journal of Plastic Surgery, Huffstadt, with J. M. H. Borghouts and A. J. Moolenaar of the University Hospital of Groningen, expressed preference for the simplicity and freedom from fistulae of the Rosenthal type of pharyngeal flap. Their flap was based centrally and as high as possible, including the whole width of the dorsal nasopharyngeal wall. When sutured into the prepared cleft on the soft palate, the flap lies almost horizontally. As the donor area healed and contracted, they noted, the base of the flap was raised even higher.
Chronic atrophic rhinitis or ozena, characterized by atrophic nasal and pharyngeal mucosa, formation of crusts and a repulsive smell, has an unknown etiology and a rare spontaneous cure. In 1976 A. J. C. Huffstadt and P. E. Hoeksema of Gröningen advocated reduction of nasal airflow with a pharyngeal flap. They reported:

The first 10 patients were treated with the wide flap we use for rhinolalia. All of them had some difficulty in nasal breathing. Next, the original Rosenthal (1924) method with a narrow flap and closure of the donor area was performed but it was obvious that this was very much less effective than the wide flap.

A flap of about three-quarters width of the dorsal pharyngeal wall is now used as a compromise between an effective reduction of the nasal airway and reasonable breathing.

**LATERAL ADHESIONS FOR A LARGE PHARYNX**

Harold L. D. Kirkham was a plastic surgeon particularly interested in ears and palates. Born in England, he worked his way as a youth to America on a freighter, studied medicine at the University of Texas and returned to England for plastic surgery training with Gillies. A U.S. Navy veteran of both world wars, Kirkham was chief plastic surgeon at San Diego Naval Hospital and later at the U.S. Naval Hospital in Houston. He received the Legion of Merit and retired a captain. He was exceptionally talented beyond his surgery, excelling as a painter (he exhibited his prize-winning work, “Three Monks,” in New York City), and as a violinist for the Houston Symphony. He never took a trip without his golf clubs and seldom returned without a trophy. Once he surreptitiously arranged for golfer Sam Snead, then an enlisted man with a back ailment, to remain a couple of extra weeks in the San Diego Naval Hospital so he could improve his golf game during afternoon sessions at a local golf course. This tall, lean Britisher, who turned into a drawling, tall-tale-telling Texan, could attract and hold a crowd all evening with his fascinating yarns. His favorite palate tale involved a family who came to consult him about the daughter’s cleft palate. During the
consultation he asked the mother whether there was any history of this deformity on her side of the family, and she denied any clefts. Then he asked:

What about your husband’s family?

The mother said that she did not think so, but that he was out in the waiting room. Kirkham called the father in, noticing a typical cleft lip scar, and inquired:

Is there anything like your daughter’s deformity on your side of the family?

The father answered in severe nasal speech:

No, there ain’t nothin’ like that in my family.

Kirkham then looked in the father’s mouth and finding an extensive cleft of the entire palate, asked:

What about that hole in the roof of your mouth?

The father replied, again nasally:

Oh that ain’t nothin’, it’s been there all my life!

In 1927 Kirkham revived the velopharyngeal adhesion principle. His comparison of measurements of normal and cleft palate specimens of the same age at the Hunterian Museum of the Royal College of London indicated that velopharyngeal insufficiency was due more to the widened pharynx than to the shortened velum. He attempted to shorten the superior constrictor muscle by denuding lateral portions of it and suturing these raw areas to corresponding denuded sides of the palatopharyngeus muscles. Although the application of the principle in a 6-year-old boy was a failure, the importance of the wide pharynx was brought to the attention of palate surgeons.

LATERAL FLAPS

In 1932 Réthi designed an operation for “rhinolalia aperta” to correct the effect of an over-large velopharyngeal space. He turned a mucosal flap from the lateral posterior pharyngeal wall based medially and obliquely. To face this flap, he lifted, in leaf-of-book
fashion, a mucosal flap from the posterior pillar of the fauces, based inward. These two flaps were coapted with sutures. Réthi advised repeating this operation on the opposite side when one procedure did not overcome velopharyngeal insufficiency. He reported two successful cases. This rather intriguing modification has never enjoyed popularity but possibly has more merit than realized.

The Kirkham-Réthi principle was revived by Richard Trauner of Graz in the mid-50's, as noted by his teacher Rosenthal, who wrote in the 1957 Stockholm Transactions:

He performs an orificial closure of the velum, leaving the patient only a median aperture for breathing.

Rosenthal presented his modification of Trauner's modification of Kirkham-Réthi lateral attachments.

**PHARYNGEAL FLAPS WITH BASE SUPERIOR**

It is not generally realized that, although Schoenborn started with an inferiorly based flap, he eventually changed to a superiorly based flap and gave sound, logical reasons for this switch. He also noted the possibility of dividing the flap attachment years later. In 1886 he wrote:

With time, the method of operation becomes simple. . . . A rather wide flap of the posterior pharyngeal wall is developed. Now, I regularly place its base cranially, high up around the pharyngeal tonsil. (Formerly, I made the bases
of these flaps caudally, but this is not ideal because the mucosa from the region of the adenoids is not suitable for suturing, being extremely fragile.) This flap is detached with the help of a long hooked forceps, and with Cooper's scissors. It is sutured to the raw edges of the two halves of the soft palate.

After 6 to 8 weeks, the wound in the wall of the pharynx is healed and uranoplasty can be undertaken. However, it is better to wait about 6 months, during which time the width of the cleft in the hard palate diminishes.

I am convinced that the operation should aim at later dividing the connection between the velum and pharynx again, if the patient maintains acceptable speech for some years.

In 1892 Bardenheuer suggested using a pharyngeal pedicle with its base superior.

**Padgett**

Earl Calvin Padgett of the University of Kansas School of Medicine, Kansas City, Missouri, was born into a family of bankers in a small town in Kansas. Against family tradition, he decided to go into medicine and was refused financial assistance. After graduation from Washington University School of Medicine in St. Louis, he was honored by an offer of a position with Harvey Cushing at Harvard. Unable to afford the required stipend, he remained in St. Louis to train with Vilray Blair, under whose tutelage he thrived. Later he popularized the pharyngeal flap in the United States, reporting results in 1930, 1936 and 1947. He was particularly interested in its use in cleft palate cases in which previous surgery had been unsuccessful. With Kathryn Stephenson in a 1948 book, Padgett stated:

> When the base is downward, one can get very little length to the flap. Therefore, we have used the flap with the base upward near the adenoid tissue and somewhat wider and longer than shown by Rosenthal.

In reference to maintaining the palatopharyngeal synchia, Padgett explained:

Ordinarily, the pedicle is left attached for a variable period of time and then cut. But in 3 instances, after the pedicle has been severed, the patients requested reattachments as speech seemed better with the pedicle attached. Although it may not be physiologically the ideal procedure, it
will allow one to close a very large defect of the soft palate with surprisingly good functional result.

Sanvenero-Rosselli

As early as 1935, Gustavo Sanvenero-Rosselli of Milan, Italy, suggested that a superiorly based pharyngeal flap be used with a Veau palate closure. This type of pharyngeal flap has become popular over the years, and 30 years after his original proposal, Sanvenero-Rosselli, at the Second Hamburg Symposium, reiterated his confidence in the superiorly based flap:

The backward and upper attraction of the velum that we obtain with the superiorly based flap is more similar to the attitude the latter assumes in normal speech conditions: the extreme portion of the soft palate remains free and mobile, the narrowing of the undue space between palate and pharynx occurs at the right level, and at the same time, also, the upper nasal resonating cavity becomes narrower.

As he said in Hamburg in 1964:

A diligent utilization of the remaining tissue, integrated with a pharyngeal flap of maximal size, offers a possibility of repair.

He diagramed his use of a superiorly based flap to close a large anterior palate fistula.

During a visit with Sanvenero-Rosselli in Milan in 1948, I was impressed with his sophistication in the handling of flaps in the operating room. Like Gillies, he was a flap man, which predilection probably explained his infatuation for pharyngeal flaps. He had great vivacity even in his later years, and when the announcement came that the Fourth International Congress of Plastic Surgery was to be held in Rome, he sprang to his feet and
screamed at the top of his voice to the entire assembly, “Vive la Deuchia!” As David Matthews wrote of him in 1974:

Sanvenero will be remembered for the warmth of his personality, his courtesy, his impeccable good manners, his immaculate dress, his charm and his enthusiasm. It can truly be said that he was surgically an aristocrat to his fingertips.

Moran

The dapper, fiery Pete Moran, surgeon to the Washington Redskins football team, in 1948 presented cleft cases using a superiorly based pharyngeal flap, which in 1951 he reported had been found beneficial also in the congenitally short palate and the paralyzed palate.

About this time a plastic surgical meeting was being held in Washington, D.C., and Pete Moran invited a group of his friends to make rounds with him to see his favorite cases. Without Moran's knowledge, his friends got together and decided to pull his leg. To add to the pomp and ceremony, Moran, a devout Catholic, had arranged that the hospital's Mother Superior be in attendance. Rounds started and Moran showed one of his remarkable temporal decompressions for exophthalmos. The surgeons accepted the case quietly with, "We have all seen these before, Pete. What else do you have?" Moran took the group by the animal lab and showed them a dog with a skin tube pedicle attached to the canine's heart in an attempt to increase the vascularity of the myocardium. The surgeons' nonchalance was expressed with: "We've seen this before." Moran's face began to show a tinge of purple but he led the way to the next patient with a partially paralyzed palate who spoke remarkably well with the aid of a superiorly-based pharyngeal flap. He received the same: "But we all have seen this before many times, Pete." Whereupon Moran reached over and pinched the right reverend backside of the Mother Superior with "Ever seen anything like this before?"

He was requested officially to leave the hospital and, as had happened before, he ordered a fleet of ambulances and evacuated his patients to another hospital until all ruffled feathers had been settled.

In 1951 Fred Dunn of New York wrote:

From my experience, the pharyngeal flap operation described by Dr. Moran is the most important surgical contribution thus far presented in aiding speech in those cleft patients who have had their palates closed and still do not speak well.
Maverick Richard C. Webster of Brookline, Massachusetts, had an important impact on American cleft palate surgery and on pharyngeal flaps. In the middle 50's he was active in getting plastic surgeons involved in the American Association of Cleft Palate Rehabilitation, then primarily orthodontists, otolaryngologists, prosthodontists and speech pathologists. The group became known as the American Cleft Palate Association, started the *Cleft Palate Journal* and elected Webster their president for 1962–1963. Excerpts from his reminiscences in 1976 are pertinent:

I am almost certain that it was in 1951 that I first was impressed by the pharyngeal flap procedure. Pete Moran presented material on this operation in the amphitheater at the Massachusetts General Hospital. He had 4 or 5 tape recorders and tapes demonstrating speech of patients before and after pharyngeal flap operations. Picture the scene: he has just finished telling how good the operation is and now he will show the speech results. He turns the first machine on, there is a puff of smoke and a smell of fused wires, his face gets redder than usual, he apologizes, and punches the "on" button of the second machine. Again, a crackling noise, some purple flashes, some smoke and plenty of ozone. His face gets redder; his temporal vessels begin to pulse. We hear some pungent Moranisms and he pushes the "on" button of No. 3. More of the same. The audience is mumbling, embarrassed, and some are beginning to laugh. I'm racing down the steps, trying to keep him from getting at the last machine, because I know that the amphitheater has DC current and that his tape players must be for AC current only. Just before his hand hits button No. 4, I grab his wrist and physically interpose myself between Moran and the last machine. His temporal vessels are pounding so severely that he is about to have a stroke. I explain the archaic wiring of the "old" Massachusetts General Hospital, that I have a converter, and that I will be happy to go get it. By the time I get back with it unfortunately there is no audience left. However, Dr. Moran and I listened to every tape and I heard speech results that, although not perfect, were definitely better than my push-back procedures were giving me. Pete was kind enough to spend the time explaining his operation in detail. He, like the others before him, made narrow flaps and tried to close the pharyngeal donor area.

Having done adenoid surgery and pharyngeal tumor work, I reasoned that wide flaps made from salpingo-pharyngeal fold to salpingo-pharyngeal fold would give even more effective velopharyngeal closure and that no attempt should be made to close the donor area, at least in most cases. My first procedure went well surgically, but the child had a cardiac arrest and
expired when coming out of anesthesia. Obviously, plenty of fear was involved in doing the second and the third procedures. However, the results were so impressive that we continued and gradually extended the procedure to other applications.

A wider flap

In 1956 in *Plastic and Reconstructive Surgery* Webster, with R. J. Coffey, J. A. Russell and L. F. Quigley of Brookline, Massachusetts, advocated the widest pharyngeal flaps yet dared and showed little concern for the closure of the secondary defect in the pharynx.

Webster classified various pharyngeal flaps as to their base position, inferior or superior, and their method of attachment to the palate, edge to edge, split border, denuded edge and turnover flap.

Quite apart from wide pharyngeal flaps with no concern for donor area closure, Webster reminded me of his early advocacy of primary pharyngeal flaps for

closure of non-cleft defects, supplementation in palatal paralyses, early primary cleft closure (before Dick Stark, I believe), and in combination with speech and orthodontic appliances, allowing deferral of hard palate cleft closure until later in life.

More than once Webster has proved to be ahead of his time, and some of his pioneering, which formerly met antagonism, has now gained approval. Here is one example in which his vision led him in a direction I feel personally was unfortunate for palate surgery:
It was obvious that much cleft palate care in America was going to be provided through government, and certainly, here in Massachusetts, government dictation was a fact of life. Although I have never found anything more interesting or challenging than the care of the cleft lip and palate patient, knowing my own character or code, I knew that I could not function as a free man with government running the show. That is why I stopped being active in the palate field and became engaged in the surgery and medicine of appearance.

This reminds me of another free spirit, Wardill of Newcastle, who left his homeland and palate surgery because of the threat of governmental intervention. There are many examples of this withdrawal throughout medicine. Eventually, of course, it will take its toll by discouraging people who lead the way from going into medicine in the first place, to the ultimate detriment of the quality and progress of this great field.

Webster indeed started a trend toward wider pharyngeal flaps for more effective closure of the incompetent velopharyngeal aperture. As with most fads, the pendulum swings too far. Some thought it was impossible to make a pharyngeal flap too wide. However, in 1964 Stuteville and Bzoch found hyponasality in 15 out of 40 patients with wide superiorly based secondary flaps. This caused Weisman to state:

It would seem reasonable to vary the width of the flap in proportion to the shortage of tissue, favoring a narrow flap when possible. For young children our flaps were 8 to 13 mm wide, 15 to 22 mm in length.

In 1977 Ken Bzoch of the University of Florida re-emphasized the danger of the broad flap:

I am concerned about one of the regular sequelae of broad, obturating pharyngeal flaps used either as primary or secondary surgical methods. Sequelae regularly include mouth breathing. This has an adverse effect upon the muscle tone of the facial muscles and on the direction of growth of the jaws. The “adenoid facies” which results may present a greater handicap to orthodontic and facial appearance correction than any other post-surgical sequelae from palatal closure techniques. Recent observations of the Chase Type Push Back with incorporated pharyngeal flap appear much less frequently to lead to mouth breathing sequelae.
Fishtail attachment

In 1977 Dennis Walker of Johannesburg began using a variation in the attachment of the pharyngeal flap to the velum, slightly reminiscent of one of Webster's designs. He described his modification:

An additional manoeuvre I have started to use removes a strip of mucosa from the pharyngeal surface of the flap and inserts the double raw edge thus produced, into a slit, somewhat like a fishtail, opening right across the free back edge of the soft palate, following a curve from the tonsillar fossa and across the uvula to the other side. The raw part of the flap is then inserted and sutured as shown. The edges can be reinforced with one or two simple sutures. This procedure helps to give a bigger area of union.

In 1978 in the *British Journal of Plastic Surgery* Dan Mahler and Yoram Levy of Ben Gurion University Medical School of Negev Beer-Sheva, Israel, presented a similar method for attachment of a superiorly based pharyngeal flap. It had been used successfully without dehiscence in eight patients 4 to 7 years of age. A standard flap is elevated, held by two long sutures at its distal corners and infiltrated with saline while the distal mucosa is de-epithelialized with delicate curved sharp scissors, leaving enough dermis to protect the vascularity. With the same scissors the posterior edge of the soft palate is split, developing a pocket between the oral and nasal layers. Into this pocket the denuded pharyngeal flap is guided and fixed with four long 4-0 silk sutures.
tied on the oral side. The distal end of the flap should be close to the posterior edge of the hard palate. The edges of the distal velum are sutured to the mucosa of the sides of the pharyngeal flap.

\[ \text{Middle third nasal turnback flap} \]

In 1963 at the Third International Congress in Washington, D.C., Harry M. Blackfield, with J. Q. Owsley, E. R. Miller and L. I. Lawson of San Francisco, presented their modification of the superiorly based pharyngeal flap. After study of normal velopharyngeal action as well as function in palates with pharyngeal flaps attached, using cinefluorography with a synchronous sound track, they altered their flap design. They split the soft palate for exposure and sutured a wide, superiorly based flap into the middle third of the nasal aspect of the soft palate after this area had been denuded by reflecting mucosal flaps backward off the soft palate. The turnback flaps were used to cover the raw undersurface of the pharyngeal flap. They concluded:

It is hoped that higher attachment of the pharyngeal flap with its undersurface lined with mucosal flaps from the palate will reduce the shrinkage of the flaps and will provide a more normal velopharyngeal closure, by aiding the palatal excursion in a more physiologic way.

\[ \text{Velar split exposure} \]

Wallace H. J. Chang of the University of Massachusetts, Worcester, was described by his former chief Willie White as, the only Oriental I know with a Southern accent.
In 1978 Chang suggested the use of a partial midline split of the velum for exposure. An incision through the oral mucosa and muscle, extending from the posterior edge of the hard palate to a point 2–3 mm. proximal to the base of the uvula, enables dissection of a distally-based nasal mucosal flap from the superior surface of the velum to create a recipient attachment site for a superiorly-based pharyngeal flap and to supply cover for the raw undersurface. Chang cites these advantages:

This technique allows (1) increased facility in dissection and (2) precision in the design of the flap for lateral port control. The procedure obviates an extra suture line in the lining flap, as is necessary in the standard complete palatal split technique.

The longest flap

Johanson is a virile Viking not particularly known for his surgical timidity. In 1958 he savored a triumph when he ventured all the way down the pharynx to the larynx for a pharyngeal flap which, based above, could reach forward to the alveolar cleft.

At the Second Hamburg Symposium he elaborated:

The use of posterior pharyngeal wall supplies us with very suitable tissue, bringing into the palate not only mucous membrane but also muscle tissue. . . . For that reason we raise a flap which is so long that it can reach the terminal end of the palate, just posteriorly to the incisors. We do this by pharyngotomy, and we free the larynx and go in through a lateral incision and raise the flap about 3 to 4 cm. From this approach, we close the pharyngeal wall carefully with stitches, put a stitch in the top and bring it
out through the mouth, and then perform the rest of the operation by the oral approach. You get in this way a very beautiful and well-supplied flap which is long enough to cover every defect in the palate. . . . There is enough material in the mucoperiosteal tissue to bring down to cover the oral defect. If not, then you can let the flap go up . . . and over the margin to the nasal side. . . . We always try to cover the defect in the hard palate with a bone graft so we need a lot of tissue. . . . I believe you should suture the soft palate in front over the raw base of the flap to avoid scarring of the base.

**Superior suspensory flap**

Milton Edgerton, in *Plastic and Reconstructive Surgery* in 1965, advocated the suspensory pharyngeal flap as an adjunct in correction of velopharyngeal incompetence. He justified this type of flap attachment with:

It has often been noted that elevation of a prosthetic speech bulb to a higher level in the nasopharynx will usually improve voice quality. Similarly, the use of a superior pedicle with a pharyngeal flap seems to aid speech in some patients more than an inferior pedicle.

Speech analyst W. Hardy pointed out that mobility and elevation of the soft palate normally play a major role in the formation of the diphthongs (speech sounds that change from one vowel to another on the same syllable). Thus Edgerton reasoned that in secondary cleft palates with speech problems involving a conspicuous merging of diphthongs (*cow, about, vacation*), the need exists for more elevation of the soft palate.
The suspensory pharyngeal flap is based high superiorly, includes muscle and is 3 cm. wide. It is brought through a horizontal slit on the dome of the soft palate and attached by bending its tip back 90 degrees and suturing it to a superficially denuded area on the oral surface of the soft palate.

Edgerton suggests that the muscle in the flap may lift the palate but admits:

This lifting is not consistently present and usually is seen only as a 2- to 3-mm. dimpling of the palate on swallowing.

He concluded:

At the present time this operation is suggested as of possible value in patients with long, immobile or paralyzed palates who are having difficulty with production of diphthongs in speech.

*Anteriorly superiorly based flaps*

In 1974 in the *Cleft Palate Journal* R. Massengill and N. Georgiade of Duke University proposed an anteriorly superiorly based pharyngeal flap. The design of the flap has its base at a superior level, wider than the tip and containing mucosa, fascia and muscle. A transverse curved incision 3 to 4 cm. in length is made through the soft palate, 1 cm. posterior to the hard palate. The tip of a pharyngeal flap is folded as a knuckle and drawn to the incision for attachment to the soft palate.

This procedure was carried out on 18 patients varying in age from 4 to 39 years. The results were compared with 17 standard superiorly based pharyngeal flaps and 5 inferiorly based flaps.
The authors reported:

Cinefluorographic analysis dealing with velum movement showed that the anteriorly-superiorly based group as a whole had more movement than the control group. When the oral and nasal sound pressure recordings were compared for the two groups the anteriorly-superiorly based group as previously discussed had consistently better type readings.

**Lining the superior flap**

Nobuhiko Isshiki and Masanori Morimoto of Kyoto University School of Medicine, Japan, in 1975 modified the method of lining the superiorly based flap and the method of forming its superior suspensory attachment. They folded the pharyngeal flap to minimize the postoperative scar contracture and shrinkage during the healing phase. A superiorly based flap was elevated from the posterior pharyngeal wall and folded on itself with the mucosa outside. The flap-velum connection was made through raw surfaces produced by denuding both lateral areas of the ridge fold of the flap.

The flap-velum attachment is a little complicated. The lateral portions on each side of the ridged fold of the flap were denuded to present raw areas. Two corresponding penetrating incisions on the sides of the soft palate were made. Then, with mattress sutures passing from the velum to the pharyngeal fold and back,
the knuckle of the flap was pulled into the nasal side of the soft palate until tethered by healing.

Isshiki, who received the Gould Award for laryngeal research and the Cultural Prize of the Kyoto Shimbun newspaper for clinical cleft lip and palate work, evidently accepts few boundaries. Admitting no special personal abilities in ESP and only a purely scientific approach to its understanding, he stated:

I do not find it surprising that there may be phenomena such as these which are inexplicable by our present understanding of the physical universe.

Lateral pharyngeal port

As Dorrance noted, Schmidt determined by experiments that speech could remain normal while there was a rubber tube with a lumen of 6 mm. between the velum and the pharyngeal wall, but when a tube of a larger lumen was inserted, speech became nasal. He concluded that the superior constrictor muscle of the pharynx was capable of overcoming a certain amount of insufficiency which, if increased beyond 6 mm., could not be controlled by this muscle.

Michael Hogan of the New York University Medical Center, first in 1971 and then in more detail in the Cleft Palate Journal in 1973, presented his lateral port control (L.P.C.) pharyngeal flap. Under the premises that velopharyngeal incompetence or inadequacy is the primary cause of cleft palate speech and that the velopharyngeal sphincter becomes incompetent when, after maximum contraction during connected speech, the residual nasopharyngeal orifice or port remains too large for normal speech production, Hogan turned to the literature for a gauge on the size limit of the port.

D. W. Warren, in 1964 and 1966, analyzing aerodynamic pressure-flow patterns of consonant production in normal speech, concluded that oropharyngeal air pressure began to diminish rapidly when the velopharyngeal port exceeded 10 mm. and that nasal escape of air was clearly evident at 20 mm. N. Isshiki, I. Honjow and M. Morimoto, in 1968, utilizing acoustical as well as aerodynamic techniques, found a port size of 5 mm. in diameter to be the approximate threshold for occurrence of hypernasality. L. Bjork, in 1961, utilizing basal radiographic tech-
niques, estimated that incompetence occurs with a port size of 20 mm² in area. Hogan concluded:

Thus if the velopharyngeal port is greater than 20 mm² in area during connected speech, hypernasality and nasal escape will tend to be present. The 20 mm² area thus appears to represent the threshold of velopharyngeal incompetence.

Hogan’s goal was to design an operation to construct the velopharyngeal port size during connected speech below 20 mm² in area. Success in this endeavor would give a competent sphincter, eliminating direct defect in cleft palate speech of hypernasality and nasal escape, and permit the patient and the speech therapist to eliminate the indirect speech maladjustment—pharyngeal fricatives, glottal stops, poor tongue positioning and nasal grimacing.

Hogan decided to change the standard superiorly based lined pharyngeal flap which was being used in conjunction with Veau-Wardill-Kilner palate pushback. This flap was giving the New York University surgeons 60 percent excellent results, 20 percent improvement and 20 percent no improvement. He explained that in the standard flap, if unlined or too narrow, the lateral ports became too large on account of shrinkage, as shown.

In his design of the lateral port control operation,

The lateral margins of the [wide] pharyngeal flap are sutured to the superior portion of the soft palate, laterally to the lateral pharyngeal wall almost
completely to the base of the pharyngeal flap. Port size is controlled by a measured catheter with an external diameter of 4 mm and thus positive control is exerted over the size of the port for the first time.

This series of drawings from Hogan’s 1973 L.P.C. paper shows a wide, superiorly based pharyngeal flap being lined by nasal mucosal flaps from the soft palate, as the lateral ports are reduced around a 4 mm. catheter. It produced, he reported, a total port size of about 25 mm.² in area (12.5 mm.² + 12.5 mm.²), counting on mesial movement of the lateral pharyngeal walls to obliterate the residual space. He claimed restoration of competence to the velopharyngeal mechanism in 97 percent of 93 patients with a mean age of 16 years. Aerodynamic measurements of the 91 successfully treated patients showed an average velopharyngeal patency during speech of 5.8 mm.². As would be expected, hyponasality was noted, but surprisingly, Hogan remarked:

Persistent hyponasality (lasting more than 6 months) was found in 3 cases. Hyponasality lasting longer than a year called for surgical correction. A catheter passed intranasally presented the pressure area of its tip intraorally to define the obliterated lateral port. Incision through this area allows the catheter to pass into the oropharynx and the catheter is left for 5 to 7 days, to allow epithelialization to insure permanent patency.

By 1976, Hogan reported:

The complications of the lateral port control procedure may include persistent hyponasality, absence of nasal respiration, snoring and excess mucus production. . . . When absent nasal respiration with concomitant mouth breathing persists for a period greater than 1 year in the growing child, consideration is given to reopening the ports. . . . One should be cautious in reestablishing the patency of the port in the growing child, as very often, with growth, patency will be established over a period of several years as the naso- and oropharynx expand in size. The only indication for operating sooner is when the patient and parent find the existing situation intolerable.

However, in the adult, when hyponasality persists for a year . . . the lateral ports should be established by the catheter technique.

Reed Dingman’s comment in the 1975 Year Book is interesting:
A 97% success rate of establishment of velopharyngeal sphincter competency by lateral port control in patients with a mean age of 16 years is highly significant.

Creating an obturator of scar with a controlled port

For the severely scarred, shrunken, shortened, non-mobile soft palate, Herfert in 1955 recommended turning a fold-back flap from the middle of the soft palate for an attachment to a pharyngeal flap. According to Perko, this left the lateral ports too large. In the 1973 *Journal of Maxillofacial Surgery*, Milivoj Perko of Zurich extended the fold-back principle across the entire width of the palate as two flaps A and B turned from the oral side of both the hard and soft palate. A wide, inferiorly based pharyngeal flap C was lifted to overlap part of flaps A and B to create a bridge of scarred tissue with remaining raw areas. It was a means of producing a non-dynamic obturator to fill partially the velopharyngeal aperture. Perko noted that this enabled him to fulfill Trauner's 1973 challenge that the lateral ports should be 3 mm.

Design of flap width by logic

In 1967 H. L. Morris and D. C. Spriestersbach of the University of Iowa reported on the pharyngeal flap as a speech mechanism. Speakers with successful pharyngeal flaps, they said, revealed either mesial movement of the lateral pharyngeal walls or superior-posterior movement of the palatal flap structure, with the mesial movement of the lateral pharyngeal walls the better predictor of pharyngeal flap success.
Thus it is logical to cut the pharyngeal flap the width necessary to fit between and touch the medial excursion of the lateral pharyngeal walls. This is the plan designed by Donnell F. Johns and Kenneth E. Salyer of the University of Texas Southwestern Medical School, Dallas. Under topical anesthesia, the medial excursion of the lateral pharyngeal walls is marked with methylene blue on the posterior pharyngeal wall. Then, under general anesthesia, incisions along these marks fashion a flap of exact dimension based superiorly above the tubercle of the atlas to fill the sphincter gap.

**Evaluation of flap attachment**

In 1977 Michael Lewin, A. Daniller, C. Croft, and R. J. Shprintzen of Montefiore Hospital, the Bronx, compared three methods of insertion of superiorly based pharyngeal flaps of similar width:

The methods of insertion were: (1) midline splitting of the velum with levator retroposition and insertion of the PF into the midline split, (2) horizontal splitting of the velum along its posterior edge with insertion of the PF “sandwich” style; (3) Dorrance pushback combined with PF. Over 100 patients were examined at least 6 months postoperatively with multi-view videofluoroscopy and nasopharyngoscopy. . . . The sandwich method resulted in maximum obturation, the Dorrance with the least. The midline split method resulted in moderately wide PF.

**TIMING THE PHARYNGEAL FLAP**

At the Association meeting in Chicago in 1977, the Lancaster group of Harding, Mazaheri and Krogman, using the standard lip (3 months) and palate (18 months) closure, reported a 20 percent velopharyngeal incompetence rate. A retrospective study to see whether the failure cases could be predicted revealed that prior to three years, there were no significant morphological differences among the various cleft groups. In the cleft-palate-only group the velum was longer two years postoperatively, but between three and six years, measurable differences in length of the velum were consistent with velopharyngeal incompetence. Since speech improves as a function of maturation between ages 3 and 6, Harding and his colleagues advocated a superiorly based pharyn-
geal flap at a mean age of 6.5 years (definite V.I. at 3 to 4 years), with over 90 percent of all patients achieving acceptable speech. Randall rose to take issue with this timing, referring to Ralph Hamilton’s law: Do a pharyngeal flap the year after you should have done it. He advocated a pharyngeal flap at age 2 to 5 years, favoring early operation if incompetence is severe, and later surgery if it is borderline.

A HITCHING POST OF LAST RESORT

Attachment of the palate to the pharynx is not natural or nature would have prearranged for this mechanism long before surgeons found their way to the palate. Yet time and experience have shown that the pharyngeal flap does work to advantage in many cases. The combination of reducing the size of the nasopharyngeal vault, obturating some of the velopharyngeal space with the actual flap and either dragging the palate back or holding it in its “pushback” position contributes toward its success. Beware of obstructing the nasal airflow as can happen with very wide pharyngeal flaps. Not only does this unphysiological condition cause destructive changes in the nasal mucosa and decrease lung function, but it can be responsible for hyponasality in speech, which may be more objectionable than mild hypernasality.
THE debate over the merits of the inferior versus the superior base of a posterior pharyngeal flap has been violent and will continue to rage, even to the point of hyponasality. Schoenborn started with an inferior base but later switched to the superior one. The two Irishmen Conway and Moran, who were always fighting over something, took opposite sides on the base of a pharyngeal flap, Conway preferring the inferior base, claiming it was easier to develop and attach, while Moran championed the superior base, boasting fewer middle ear complications and easier control of postoperative bleeding. Before and since, surgeons have lined up on one side or the other. In general, the inferior base is considered easier to attach, while the superior base is touted as giving a larger flap more effective in speech improvement.

Then there are those surgeons, like Skoog, who feel that the position of the base makes no difference. In a 1965 retrospective study of 82 patients (49 flaps superiorly based, 33 inferiorly based), Skoog found it difficult to tell which was which. In 1970 M. Hamlen of Toronto reported a retrospective study of 91 patients with pharyngeal flaps (64 superiorly based and 27 inferiorly based). He was unable to demonstrate any significant difference in short- or long-term results. According to Yules and Chase:

More centers seem to be switching to superiorly based flaps—especially in difficult cases.
Fára and Vele noted in 1972:

Two autopsies, six biopsies and 154 electromyographies were the basis for a biological assessment of primary pharyngeal flaps, both superior- and inferior-based. It was determined that the inferior-based flap preserved its muscle content in a better state than did the superior-based flap, the latter demonstrating a greater degree of muscle atrophy and fibrosis. Nevertheless, the superior-based flap provided for far superior dynamic palato-pharyngeal closure than did the inferior-based flap, provided the patient has a functional nasopharyngeal musculature.

In 1972 Whitaker, Randall, Graham, Hamilton and Winchester of Philadelphia compared superiorly and inferiorly based posterior pharyngeal flaps. Seventeen superiorly based flaps were placed high on the nasal side of the soft palate. Eighteen inferiorly based flaps were inserted on the oral side, well up into the muscular part of the palate with a turnover flap of mucosa to line the raw side. A randomized evaluation of 35 patients with velopharyngeal incompetence, who had posterior pharyngeal flaps applied during 1966 through 1971, revealed 17 percent with residual "slight" incompetence but 97 percent with normal speech or with "slight" distortions. The authors stated:

There were no significant differences between superiorly and inferiorly based flaps in postoperative speech, hearing acuity, short and long term complications or length of hospital stay. Sex of the individual and extent of the cleft also did not affect the outcome. From this data it would appear that anatomic or technical considerations are therefore the only relevant factors in deciding on whether to do a superiorly or inferiorly based posterior pharyngeal flap.

In 1973 Randall, for Grabb and Smith, stated:

The inferiorly based posterior pharyngeal flap is constructed more easily than the superiorly based flap. It has the advantages of acting somewhat as a sounding board to direct the airstream into the mouth, it may well be located at a level where the greatest amount of lateral pharyngeal wall motion takes place, its construction does not require opening the soft palate repair, and it lends itself well to secondary procedures which may be needed to make the lateral openings larger or smaller.

The superiorly based posterior pharyngeal flap, on the other hand, can be raised in greater length and can bridge a larger gap. . . . Its base is located nearer the usual site of velopharyngeal closure, and as it contracts it tends to
pull the palate in this direction. To attach such a flap usually requires reopening the soft palate repair. . . . It is often difficult, even on x-ray examination, to tell the difference between superiorly and inferiorly based flaps, as each tends to approach the same point during the healing process. . . . Accordingly, my preference is usually for the inferiorly based flap, and particularly if exposure is difficult, if the patient is in poor condition, or if the palate is so mobile. . . . On the other hand, if the space to be bridged is great, a superiorly based flap must be used, or the palate would have to be lengthened at the same operation.

In 1976, at the American Cleft Palate Association meeting in San Francisco, P. Randall, with Whitaker, Noone and Jones, “rehashed” this old argument under the title “The Case for the Inferiorly Based Posterior Pharyngeal Flap.” They did note that as the use of the inferiorly based flap is easier, exposure more satisfactory and time of operation shorter, it was preferred in patients with jaw deformities such as those with Treacher Collins syndrome or with Pierre Robin anomaly . . . also . . . poor operative risks . . . and poorly nourished.

Randall gave the bottom line:

If there is no demonstrable difference and some reasons pro or con, then why throw one of them away?

In 1975 Ralph Blocksma, with Leuz and Mellerstig, of Grand Rapids, Michigan, reported conservative closure of the palate with the use of mucoperiosteal flaps. The palate was closed at 18 to 24 months with a modified von Langenbeck procedure. The hard palate closure is delayed until 5 years of age. These authors reported 100 conservative closures and admitted:

Pharyngeal flaps were required in 49 of them, but these flaps caused few problems.

They expressed preference for broad, superiorly based pharyngeal flaps and obtained a large area of attachment on the nasal side of the soft palate, leaving virtually no raw area.

In 1977 Bengt Nylen of Stockholm stated his preference for the superiorly based flap, citing more tissue available and safer hemostasis as the donor area is in view and can be controlled under direct vision postoperatively, if necessary.
IMPORTANCE OF THE LEVEL OF THE BASE

Whether the base was superior or inferior did not seem to matter as much as the height of the actual base itself.

Owsley and Blackfield in 1965, Skoog in 1965, and Weber, Chase and Jobe in 1970 all emphasized the importance of maintaining the upward-posterior vector of motion of the soft palate when attaching a pharyngeal flap. The low pharyngeal flap, attached at the posterior margin of the soft palate, produces traction in an inferior or straight posterior direction and may actually restrict normal palate elevation. In 1977, at a Cleft Palate Symposium in Chicago, John Owsley recalled that in the 60's a review of 21 posterior pharyngeal flaps revealed four good speech results. The contracture of the flap and the donor area had ended with inferiorly or superiorly based flaps looking the same and showing the same downward tethering. Thus, he raised his wide flap, based higher, to an optimal position well above Passavant's pad and advanced it to the hard palate and mended levator muscles with improvement in speech to 50 percent normal and 30 percent acceptable.

DIRECTIONS OF CONTRACTURE

Although I use both inferior and superior bases, my preference has always been for the superior base. There seems to be a better donor area in infants and children with less problem of adenoid tissue. There is more natural flow of the flap to the superior nasal surface of the velum. I do not find it necessary to open the soft palate. Any contracture of whatever raw surface remains on the underbelly of the flap will tend to lift the palate up toward the normal speech contact point in the pharynx, rather than drag it downward.

DONOR AREA CONTRACTURE

Of course, the donor area also influences the eventual position of the base of the flap. Most surgeons close the pharyngeal donor area for hemostasis, and most initial donor area closures open and
heal by granulation and scar contracture. It is interesting that the contracture of the donor area pulls in the opposite direction to the raw area of the flap but in a lesser degree. The donor area scar pulls upward with an inferiorly based flap and downward with a superiorly based flap.

**BOTH BASES**

In compromise or in spite, in 1961 I designed a procedure using both superiorly and inferiorly based flaps simultaneously. The reasoning was basic. In wide clefts the insertion of a pharyngeal flap in the nasal or oral side relieves the tension of closure in only one plane. The overall tightness of a waistcoat buttoned over an obese belly will show little relief with but one good gusset in either the covering cloth or the lining if the other maintains its original dimension. Thus a vertical Z of two flaps was advocated to provide both cover and lining of a wedge to be inserted into the cleft to reduce the side-to-side tightness ordinarily present after closure of wide clefts. An important factor in this double design called for both bases to be set at the same point of potential contact between the velum and the pharyngeal wall at the time of levator action.

Thus, a vertical incision in the midline of the posterior pharyngeal wall allowed a flap to be taken on either side of it with both bases placed side by side at the midpoint, which in turn was set at the potential velar contact point during action of the levator muscle. The flap with a superior base was turned over for
nasal lining and the flap with an inferior base, composed of mucosa and varying degrees of adenoid tissue dissected with care, supplied cover on the oral side. This double flap method was used in two boys, 6 and 9 years of age, who had minimal adenoid tissue.

Since the development of the island flap, there has not been a need for this rather complicated procedure. Yet if the method were to be used today, the flaps which were originally narrower than necessary would be taken somewhat wider. In fact, Kapetansky's later modification of the double flap principle with the flap bases turned more laterally in the hope of preserving at least one nerve is preferred.
Use of the posterior pharyngeal flap in primary cleft palate surgery was first reported by a German, Freund, in 1927. It is possible he was not the first to take this step. As early as 1924, F. Burian of Prague was using a posterior pharyngeal flap in combination with a primary palate pushback operation. In 1954, Sanvenero-Rosselli advocated a similar use of a superiorly based flap.

Richard Webster of Brookline, Massachusetts, and his co-workers in 1956 promoted the use of the primary pharyngeal flap and reported eight cases:

We have used posterior pharyngeal flaps in children 17 and 18 months old to aid in primary cleft closure when the width of the cleft and lack of palatal tissue led us to anticipate later sphincter incompetency.

Popularizing the Standard Primary Pharyngeal Flap

The one surgeon to popularize the primary pharyngeal flap in the Western world was undoubtedly Richard B. Stark. In 1960, with DeHaan, Stark published a paper with emphasis on the use of the primary pharyngeal flap. His first case, he reported, had been performed in 1954 on a 1-year-old child. By the time his book, Cleft Palate, was published in 1968, he had 60 primary flaps carried out in conjunction with a von Langenbeck procedure before speech had begun.

Stark is also a renowned artist with a precise, continuous-line style, as seen in his sketch of St. Luke's Hospital where many of
his primary flaps were attached. His sketches of the primary pharyngeal flap technique, the palate and pharynx, the surgical design, Dott gag and anesthetic tube, gloved hands and instruments in action are, to me, some of the clearest and finest illustrations of palate surgery.

Conway, when asked in open court what he thought of the primary flap, stated:

I am opposed to its universal use in all cleft cases.

Yet Stark’s faith in this principle has been greatly responsible for what present popularity it enjoys.

Stark’s most recent thoughts on it appear in the excellent compilation *Cleft Lip and Palate*, edited by Grabb, Rosenstein and Bzoch. Out of 86 primary flap patients, 42 were 5 years of age or more and old enough for speech testing. Out of the 42, 10 were excluded because of mental retardation, flap disruptions, tracheostomy and an unrelated death. Of the remaining 32, 3 were considered excellent, 26 good, 3 fair and none with poor or unintelligible speech. This evaluation was graded on (1) volume, (2) pitch, (3) voice quality, (4) rate, (5) rhythm and (6) articulation.

Stark based the rationale behind the flap of mucosa, submucosa and superior constrictor muscle in primary repair of cleft palate on three factors:
1. In clefts of the palate (and especially those of the soft palate alone) embryologically there appears to be an inherent paucity of mesoderm, which logically requires the addition of dynamic muscular tissue plus added blood supply in the region of the uvula.

2. A pharyngoplasty is performed simultaneously by virtue of closing the pharyngeal donor defect and of elevating the flap into position.

3. The open cleft of the palate presents the plastic surgeon with the best opportunity of both elevating the flap and closing the donor defect.

Although he agrees with Skoog that whether the flap is based inferiorly or superiorly is academic and in postoperative examination it is difficult to tell which is which, Stark still prefers the inferior base for ease of application. He does admit that when a hypertrophied adenoid pad is present a superior base is better.

ANOTHER PRIMARY ADVOCATE

In 1961 James B. Cox and Bernard Silverstein of Knoxville, Tennessee, reported 78 pharyngeal flaps, 41 secondary and 37 primary. They noted that the primary flaps were usually smaller in size, were let into the nasal side, were used in association with a von Langenbeck operation and had no postoperative breakdown or fistulae. In 1972 Cox wrote to confirm his favor of the primary pharyngeal flap in the Southeastern Society's newsletter.

I feel there is a frequent indication or need for a pharyngeal flap to augment the palate at the time of the initial repair. This feeling is based on the belief that there is a real or relative deficiency of palatal tissue in many, if not most, cases of cleft palate. The midline area of the posterior pharyngeal wall fulfills the requirements of a good donor area for tissue to augment the palate, and also, the elevation of a flap from this area offers some benefit as a type of pharyngoplasty. The addition of tissue in the midline area of the palate affords an easier, simpler closure. Better primary healing occurs and fistulae are rare. Of considerable importance is the fact that one relatively simple operative procedure can be performed safely at an early age (twelve to eighteen months) and will provide, in most cases, an adequate mechanism for speech.

Over the past 15 years, I have performed well over one hundred cases of primary pharyngeal flaps and have been pleased with the overall results. Speech results have been superior on the average to results achieved by other methods. There is a higher percentage of normal speakers among this group than in comparable groups having other types of surgery. I have
not been able to detect any adverse effect on facial development, and hearing problems have been fewer and of lesser degree.

In 1977 Cox reconfirmed his earlier findings about better speech results with no deleterious effects on growth. He recalled his first primary pharyngeal flap in 1956:

My first case was a four-year-old boy with an incomplete cleft extending through the entire soft palate and about one-eighth of the hard palate. His speech was poor with typical velopharyngeal insufficiency. I used a relatively small, midline, superiorly-based pharyngeal flap incorporating the muscle and did an ordinary simple repair. This boy, without speech training, progressed reasonably soon to essentially normal speech. In 1960, I did a report on these flaps and today I am still very pleased with the results obtained over about twenty years.

AND ANOTHER

Philip A. Weisman of the Good Samaritan Hospital, Dayton, Ohio, after 10 years of experience with the standard Wardill palate procedure noted that most palates achieved normal speech but many did not. Regarding Stark’s use of a primary pharyngeal flap in all palates, he commented:

If one could select the patients most likely to have poor results with the standard technique, the primary flap could be reserved for this group alone—without using it unnecessarily for those who would not need it. Subtelny et al. observed that after a secondary pharyngeal flap, the potential for normal speech was often established but unfulfilled. With a primary flap, the batting average should be better.

Weisman chose for consideration for a primary pharyngeal flap all complete clefts, very wide incomplete clefts, clefts with shortage of tissue and unoperated older patients. He used the primary flap in 16 out of 32 palates from 1965 to 1970.

In the first stage, Weisman employed a vomer flap to close the hard palate and added a Skoog periosteal flap when closing the lip. Then his attack on the palate had a built-in belt, suspenders and hand-holding safety series which was almost an “overkill.” He combined a Wardill V-Y pushback, levator retropositioning,
Limberg ostectomy, Z-plasty of the nasal mucosa and union of the posterior pillars of the fauces well behind the uvula. Finally, onto the oral raw area of the join he sutured a high, inferiorly based pharyngeal flap! It's a little tricky to say which does what.

Of the 16 cases, eight could be evaluated and six of them were considered by Weisman to have satisfactory speech. A hyperkinetic boy on Dilantin revealed hyponasal speech postoperatively.

Weisman summarized the value of a primary pharyngeal flap:

Disadvantages...

1. Longer operating time (slight).
2. Greater risk of bleeding (slight).
3. Increased postoperative airway embarrassment.
4. Risk of denasality (small, surgically correctable).
5. Posterior wall compromised as future donor site.
6. Interference with future nasotracheal intubation.

Advantages . . .
1. Improved chance for velopharyngeal competence during early speech development, rather than after fixation of improper habits and the emotionally traumatic embarrassment of rhinolalia.
2. Avoidance of speech therapy for many patients.
3. Avoidance of secondary surgery.
4. Easy accessibility in unrepaired child.
5. Palate unscarred by previous surgery.
6. Pushback effect secured by posterior attachment.
7. Tissue added to palate.
8. Tightening of "pharyngeal sphincter" by closure of flap donor site ("pharyngoplasty.")

In 1976 Weisman wrote a follow-up:

Since 1965, I have repaired the least favorable cleft palates with a Wardill-type pushback in combination with an inferiorly-based pharyngeal flap attached into the post-uvula area. 24 patients have been operated between 18 and 24 months, the oldest at three and a half years. 22 of these patients are at least 3 years and 19 of the 22, or 86%, have normal or virtually normal speech. . . . Only 9 of these 24 have had speech therapy. I would like to emphasize that the pharyngeal flap is reserved for those with the worst prognosis. More favorable clefts are treated with the pushback procedure alone. In a few patients with extremely wide clefts and very skimpy palatal tissue, preliminary uvular adhesion procedures were done to stimulate some muscle function. Our patients have had a high incidence of ear troubles, but I do not think any higher than cleft palate patients without the pharyngeal flap. A few patients have been mouth-breathers . . . and some of this is probably due to the flap, but some due to the deviated septums or collapsed maxillary segments. Nevertheless, I believe the flap should not be made too wide, mostly about 1 cm. In 2 cases I did a partial release of the flap secondarily and in one, a complete release to overcome some mild denasality.

Here is an interesting little story:

Lance's father never knew his mother was pregnant. Lance's mother never knew his father's last name. Lance's mother never wanted Lance. Lance was born a handsome blond baby with light blue eyes, engaging personality and a severe cleft of the lip and palate. First couple considering adoption were discouraged by the cleft problems. Then came a couple, she a handsome blond Swede with light blue eyes, and he a research psychologist whose bilateral cleft lip had been reconstructed by George Pierce in San Francisco. The adoption came quickly and was followed by a pushback repair with
primary pharyngeal flap for Lance and a lip revision for his new father. Last clinical note, when Lance was 4, indicated no teasing at school, speaking fairly well and happy.

In 1966 Robert Pool of Michigan joined those using a pharyngeal flap primarily in the closure of the palatal cleft.

AND STILL ANOTHER

At Duke University in the late 50's the Wardill V-Y pushback operation was being used, dividing the nasal mucosa along the edge of the hard palate but with no attempt to supply nasal lining. This left a vulnerable area of one-layer closure subject to breakdown and scarring. Stalwart Robert M. Woolf recalled in 1977 that as a senior resident at Duke he devoted 30 percent of his operations on the palate to dealing with fistulae. When he started in Salt Lake City, Utah, he determined to make a change and came to the Oxford-type pushback without actual nasal release. Although creating fewer fistulae, he ended up with 32 percent of the cases requiring secondary surgery for speech improvement. Thus, in 1971, at Primary Children’s Medical Center, Woolf and Broadbent began a prophylactic campaign using a primary superiorly based pharyngeal flap to supply lining to the nasal defect of the pushback. They employed this method in 76 percent of cases with a 1 percent occurrence of fistulae and have been encouraged by the apparent improvement in speech from 50 percent acceptable results to 80 percent without evidence of other deleterious effects.

In 1977 in Chicago Ray Broadbent stated:

If 24 to 26 percent of palates will need a pharyngeal flap, do it primarily on all since you can’t tell which and it’s important to speak well early.

SIDE-TO-SIDE RELIEF

It must be admitted that in rare wide deficient clefts of the palate a primary pharyngeal flap can bring in extra tissue. Usually there are better ways of accomplishing this goal, but in 1962, in Plastic and Reconstructive Surgery, I suggested a slight variation, which
can be used to relieve moderately the side-to-side tension of cleft closure. By turning edge flaps orally and inserting a superiorly based pharyngeal flap nasally, one can bring some extra tissue to both the oral and nasal lining.

During this same 1962 presentation, two other methods were described to facilitate further side-to-side relief during closure of wide clefts with a primary pharyngeal flap. One involved taking a longitudinal vomerine mucoperiosteal flap based posteriorly for the nasal closure of the soft palate cleft, and a superiorly based pharyngeal flap twisted for closure of the oral side. This procedure has not been used since that time, as the vomerine mucoperiosteum has more valuable functions.

The second method, described in Chapter 37, involved two parallel posterior pharyngeal flaps, one based superiorly, to be inserted into the nasal side of the soft palate cleft, the other based inferiorly, for the oral side.
OCCASIONAL PRIMARY FLAP

Bengt Nylén of Stockholm, the Venice of the North, is an international sailor whose Cal 40 was the leading European boat in the 1968 transatlantic race. In 1977 Nylén explained that he still uses the pharyngeal flap that Skoog taught him in 1955, inserting it at 5 to 6 years of age in about 11 percent of cases. He also uses this flap as a primary procedure:

Occasionally, we use this flap primarily in cases operated at 12 to 18 months. We do it when the nasal surface is difficult to suture. In a case like the one diagrammed, with an unoperated cleft of the secondary palate, the flap is usually 6 to 8 cm. long, based at the level of the eustachian tube openings and consisting of muscle and mucosa. I don’t suture the donor site. Added to the pharyngeal flap I’ve used small mucosal flaps from the posterior nasal surface of the soft palate to cover the raw surface of the flap. The advantages are good nasal cover and the addition of a lot of tissue, including muscle, to the soft palate. At the same time you decrease the nasal gate with the base of the flap and reduce the risk of open nasality.

OPPOSITION TO PRIMARY FLAP

Probably the majority of palate surgeons do not favor primary pharyngeal flaps except in unusual circumstances. R. N. Sharma of Lucknow, India, who was trained in England and uses the Veau-Kilner-Wardill pharyngoplasty, wrote in 1966:

Pharyngoplasty as a primary procedure in early age groups is not justifiable but it may be combined if repair is undertaken after five years of age.
K. M. Cleveland and M. L. Falk of Detroit noted in 1970 that from their study the postalveolar cleft, congenitally short palate and submucous cleft tended to necessitate pharyngeal flap surgery, whereas unilateral complete clefts treated with V-Y four-flap closure were likely to achieve normal speech without a pharyngeal flap adjunct. They also found that when primary closure was performed at the mean age of approximately 7 months, adequate speech without a pharyngeal flap was common. From these data they concluded:

Pharyngeal flap surgery should not necessarily be part of the total primary repair procedure since some types of clefts, in combination with certain procedures, will result in normal speech.

JUSTIFICATION OF PRIMARY PHARYNGEAL FLAP

Hal Bingham while at Columbia, Missouri, with P. Suthunyarat, S. Richards and M. Graham asked the question Should the pharyngeal flap be used primarily with palatoplasty? and answered it in 1972 after he arrived at the University of Florida, Gainesville:

In certain selected cleft problems, palatoplasty with a primary pharyngeal flap seems indicated. The selection is made at the time of operation and relates to the amount of tension on the closure as well as palatal length.

Out of 50 cases, they elected primary posterior pharyngeal flaps 22 times, more commonly in complete clefts. Comparison of 20 V-Y palatoplasties, 10 with primary pharyngeal flaps and 10 without, showed less hearing loss and less hypernasality in the pharyngeal flap group.

A factor concerning Bingham was the two- to three-year delay between speech development and surgery, when valuable time had been lost and ingrained speech errors required intensive therapy, a dental prosthesis, or both.

In 1973 John Curtin, with Joanne Subtelny, Nobuo Oya and Daniel Subtelny, reported postoperative results of pharyngeal flap surgery employed as a primary and as a secondary procedure for
20 posterior cleft palate patients. Statistical comparisons of speech, intraoral air pressure, nasal airflow and cephalometric measures showed that the results of flap surgery as primary and secondary procedures could not be differentiated. The findings suggested to the authors that pharyngeal flaps may be indicated in preadolescent and older patients with unoperated posterior clefts, when adequacy of velar tissue for functional closure is questionable.

David Furnas of the University of California, Irvine, endorsed the primary pharyngeal flap in certain cases when he wrote in 1977:

In recent years I have been doing primary pharyngeal flaps at the time of my palate repair in any patient where a short palate was expected. The pharyngeal flap is an inelegant, unphysiological, and tedious procedure, but pragmatically it has given me excellent results (but I'm still not satisfied—denasal speech is sometimes a problem).

Also in 1977, Randall advocated a primary pharyngeal flap for the horseshoe-type cleft with poor musculature.

**PRIMARY VELOPHARYNGEAL ADHESION**

In 1975, at the Sixth International Congress in Paris, and later in its *Transactions*, Rudolf K. Stellmach of the Free University of Berlin noted that the normal child learns to speak well spontaneously whereas the cleft palate child often does not. He accused the short postoperative velum of being the cause of velopharyngeal incompetence, requiring one out of two patients to receive speech therapy before school age, even if the palate was closed before 2 years. This situation challenged Stellmach to look for a better method of primary palate closure. He ruled out the inferiorly based primary pharyngeal flap proposed by Stark as an unphysiological procedure better suited to secondary operation. He reasoned that if the pharyngoplasty were performed only to facilitate the otherwise normal velopharyngeal mechanism it would indeed be a primary speech-aiding operation. He set these requirements:

1. no immobility of pharyngeal wall caused by scarring as with wide flaps and secondary healing
2. the entrance to the epipharynx and the nasal airways must be wide;
3. the connection between velum and pharyngeal wall must be reversible.

The hard palate in total clefts is closed first, at 18 months, by his square vomer flap. Then at 24 to 30 months a standard V-Y palate closure is combined with a miniflap from the posterior pharyngeal wall based superiorly, measuring 5 mm. wide and 15 to 20 mm. long. It is incorporated into the nasal closure, and the donor area is closed and heals without scarring.

Stellmach reported 38 miniflaps, 22 of which were followed for three or more years. Only two children with slight nasal escape required speech therapy. He concluded:

A small adhesion of the velum to the pharynx . . . does not add considerable difficulties to the palate repair nor does it change the anatomy and normal function of the velum or the pharynx muscles. It acts to simply bring the velum close to the pharyngeal wall by traction on the bridging flap and to prevent any tendency to relapse anteriorly.

If necessary the adhesion bridge can be divided later on. This might occur around school age if adenotomy has to be performed. If velopharyngeal closure was competent for two or more years there is little danger of nasality afterwards. Three cases treated in this way did not show any decrease of speech quality. The adhesion principle is useful in all cleft palate cases, which by clinical judgment do not show sufficient velum lengthening under operation.

TO FLAP OR NOT TO FLAP
PRIMARILY

During the last two decades there has been and continues to be a worldwide epidemic of pharyngeal flaps which was boosted by R. B. Stark’s advocacy of the 100 percent use of this flap primarily. In a 1960 editorial Ivy appealed for clarification of the indications and contraindications of these flaps.

As I said in 1962 and still advocate today:

Certainly, “shotgun” therapy of palate clefts with a load of posterior pharyngeal flaps without selection seems unwarranted. It is suggested, however, that in wide palate clefts, pharyngeal flaps may be indicated primarily.

Stellmach’s miniflap has some appeal and at small cost for the deserving case.
39. Forward Projection of the Pharyngeal Wall by Flaps

In 1876 Rutenberg proposed that the pharyngeal wall be brought forward to enable it to be reached by the velum. A transverse incision in the posterior pharyngeal wall, when closed with sutures longitudinally, produced a projecting ridge and narrowed the pharynx.

Passavant Again

In 1878 Passavant condemned all his previous operations and devised another for the correction of velopharyngeal insufficiency. He developed a quadrilateral flap on the posterior wall of the pharynx medial to and above the level of the Eustachian tubes, its base connecting with the mucous membrane covering the superior constrictor muscle. This flap was elevated and folded on itself to create a shelf-like projection, the sides of which were united by suture to corresponding areas on the lateral walls of the pharynx. Here was an attempt by Passavant to out-Passavant Passavant's pad. Unfortunately, the shelf flattened out in time.

Augmenting Passavant's Ridge

As Wardill of Newcastle upon Tyne once stated:

On examination of almost any unoperated cleft palate during the pronunciation of "ah" with the mouth wide open, a prominent ridge is seen running transversely across the posterior pharyngeal wall to appear into the upper reaches of the soft palate. . . . Passavant was the first to describe this. . . . With the help of my colleague, Mr. James Whillis, the superior
constrictor muscle has been shown to arise not only from the usually
described situation, but also from the palatal aponeurosis.

In 1930 Whillis suggested that

the most suitable name for this muscle is palatopharyngeal-sphincter, as its
action appears to be assisting in shutting off the nasopharynx by producing
the ridge of Passavant on the posterior pharyngeal wall.

WARDILL

In 1927 Wardill advocated a pharyngoplasty similar to that of
Rutenberg which was designed to increase the forward effectiveness
of this superior constrictor muscle ridge. As he wrote:

The pharynx is stimulated and the position of the ridge of Passavant is
noted. With a fine tenotome, the mucous membrane is incised transversely
at the level of the ridge over the anterior arch of the atlas through the
superior constrictor muscle.

He freed this muscle from the buccopharyngeal fascia, extended
the incision laterally as far as the salpingopharyngeus muscles and closed
the horizontal incision in the vertical direction, thus achieving a ridge. At this time Wardill used merely
relaxing incisions for his cleft closure.

In an overt gesture against British socialized medicine, Wardill
migrated to Baghdad where Steffensen found him and made some
pertinent inquiries. When asked, "Why not omit the pharyngoplasty in some cases?" Wardill responded with his typical, dogmatic logic:

In some cases this might be reasonable, but having gone through the time
when about one percent of successful speech results was the rule, I am
hesitant to discard a well-tried procedure which, to my knowledge, has never
done any harm.

Gillies occasionally used the Rutenberg-Wardill pharyngoplasty. As he said:

This procedure is an application of the principle of bringing the mountain
to Mahomet.
He cited an example of one case in which a Gillies-Fry push-back plus a Rutenberg-Wardill push-forward pharyngoplasty produced 100 percent normal speech:

The Wardill pharyngoplasty brought her pharynx forward in a definite ridge which is present today.

In 1947 Bentley, using the Wardill method in 87 cases, but 41 with Wardill’s pharyngoplasty and 46 without, revealed a slight superiority with pharyngoplasty. His report showed that, without speech therapy, there were 36 perfect speech results in each category. There was imperfect speech in 10 without and in only five with pharyngoplasty.

**HYNES**

Wilfred Hynes, trained by Gillies at Rooksdown House and head of FHMS 5 in Italy in World War II, developed an outstanding plastic-jaw unit nestling on a hill overlooking a little stream and woods on the outskirts of the great industrial steel city of Sheffield. With basic physiology and good common sense, which tempered him as strong as Sheffield steel, Hynes made contributions to plastic surgery. In fact, in 1950 he advocated a modified bilateral pharyngeal flap to produce forward projection of the pharyngeal wall. He raised vertical mucosal pedicles based superiorly, incorporating each salpingopharyngeus muscle. By transposing them 90 degrees, he slid them side by side to overlap each other under slight tension and sutured them into a horizontal incision through mucosa across the posterior pharynx. This maneuver created a prominent, (what was hoped to be) permanent and often contractile shelf above Passavant’s ridge to act as the posterior wall of the palatopharyngeal sphincter. Hynes emphasized that closing the donor defects had reduced the transverse pharyngeal diameter, with an improvement in the pitch of the voice. He used his pharyngoplasty in conjunction with a V-Y palate closure and advised that it not be undertaken before the age of 10 years.
Each year Hynes ventured from his inaccessible unit on a pilgrimage to see what other plastic units were doing and to report on his own work. In 1952 he had just developed his pharyngoplasty and, on his annual jaunt, he called on Gillies at Harley Street and offered to demonstrate his operation at Dollis Hill Hospital, one of Sir Harold’s old haunts. I had the good fortune to be allowed to accompany Gillies to observe Hynes in action.

After approving the Wardill-type pharyngoplasty as an adjunct in certain cases, Gillies added:

It is probable that the new, more positive Hynes pharyngoplasty will take its place.

In 1957, in *The Principles and Art of Plastic Surgery*, Gillies and I summarized:

So, whether the palate is Dorranced, Wardilled, Browned, or Gillies-Fried, with or without a tube pedicle, it still may be bolstered from be-Hyned.

*A comparison*

Williams and Woolhouse of Montreal in 1962 compared the results in 24 cases. In 12 a Hynes pharyngoplasty was performed and in 12 a lower-based pharyngeal flap was used. Oral manometer readings were considered to correlate very well with speech results. Williams and Woolhouse recommended the Hynes procedure in cases in which there was a minor degree of velopharyngeal incompetence.

*Refinements*

In 1967 Hynes clarified the recent developments of his operation. First, the entire bulk of the lateral pharyngeal muscles, including
superior constrictor, palatopharyngeus and salpingopharyngeus, was incorporated in the flaps:

The two lateral flaps are then transposed upwards and inwards and are inset into a defect high across the posterior pharyngeal wall made by a transverse mucosal incision just below the level of the Eustachian region. [One of these flaps is set into the transverse incision and the second flap overlaps the first to form a bulky (tube pedicle-like) ridge.]

Hynes emphasized more at this time the inward advancement of the mucomuscular flaps and the narrowing of the pharynx with the closure of the donor areas. He insisted that actual closure of such large donor areas permanently obliterates the pharyngeal recesses extending laterally behind the posterior pillars of the fauces (shaded areas). This is an especially beneficial outcome in the "failed cleft palate" with the "enlarged static pharynx," which, in spite of palate lengthening, continues to leak speech into the nose. As he wrote:

Thus, two synergistic slings have been created—a posterior element formed by the posterior pharyngeal ridge of the pharyngoplasty and an anterior element formed by the repaired velum.

Hynes did not advocate a primary pharyngoplasty for all clefts of the palate. He did prefer his "two-in-one" operation of V-Y pushback and Hynes pharyngoplasty in clefts of the soft palate only and in longer, wider clefts with less tissue to work with in constructing a competent velopharyngeal sphincter.

Although the Hynes pharyngoplasty was used all over the world, it became extremely popular in Britain for a couple of decades.

J. P. Reidy of London, an ardent apostle of Kilner, in 1964 gave his conclusions on pharyngoplasty and speech:

1. Where adequate palate repair is undertaken at 1 year, there is no indication for pharyngoplasty as well at that age.
2. Pharyngoplasty is indicated as a "supportive" operation only when the result of the palate repair can be assessed (5 years plus), and where the speech result proves disappointing.
3. The figure of 171 pharyngoplasties in 944 cases applies to the known speech results up to April 1963. It follows that with follow-up of the more recent primary cases, pharyngoplasty may well be necessary in some.

4. The Hynes pharyngoplasty has proved to be the most satisfactory.

I wrote to Hynes in 1971 and he responded:

About my pharyngoplasty, I well remember Sir Harold Gillies assisting me in a case some 20 years ago. The operation was done at the Dollis Hill Hospital, which as far as I remember, was a private concern—at least the patient was a private one. She was Miss McDonald whom I did not see before or after the operation and I suppose Sir Harold, pre-occupied at the time, forgot about asking me to see the patient again. I am, therefore, unaware of what he thought of the result or indeed of the operation. I can say, however, that the late Professor Kilner and his team accepted the operation with enthusiasm to the extent that they practiced this procedure extensively—and still do.

I recall 3 interesting incidents:

No. 1 I was approached by a cleft palate patient of 75 years of age, who demanded a pharyngoplasty so that he could at least utter one word correctly before he died. I need hardly say he died without the operation or realizing his ambition.

No. 2 I was approached by one middle-aged patient who wanted a cleft palate operation for cosmetic reasons. He was inclined to laugh rather easily and felt his mirth inhibited because of his fear of showing the very wide cleft in the roof of his mouth. I have never had any other request for a cleft palate operation for cosmetic reasons.

No. 3 I operated on a young parson, who was in fact a son of a Bishop, under rather pathetic circumstances. He had an insane desire to be a parson, I can say insane not because it is foolish to do this sort of thing, but because he wished to follow a profession where a good speaking and carrying voice is essential. He spoke reasonably well but could not project his voice far enough for the congregation in a normal-sized church to catch what he said. He was in fact traveling the country looking for a living with a church small enough to suit his diminished capacity.

Hynes concluded:

To the day I retired, I practiced my particular operation and was satisfied with the results. I never did the rival pharyngeal operation, so I am unable to compare the two procedures. However, I am quite convinced that my operation is the only one that meets the requirements of a patient whose pharynx shows reduced lateral movements as the lateral pharyngeal recesses are completely obliterated by my operation. Interestingly enough, my son,
D. M. Hynes of McMaster University, Hamilton, Ontario, Canada, worked out a radiological method of demonstrating the movements of the oropharynx and wrote it in *Clinical Radiology* in 1970.

In 1976 Joss of Norwich, England, wrote:

My colleague here, Frank Innes, uses a pharyngoplasty by Hynes, but there are very few people who use this method now.

Also in 1976, Innes wrote to explain his approval of the Hynes pharyngoplasty:

When the pharynx is too deep and too broad from side to side, the term “cavernous” is frequently appropriate: the best possible pushback of the soft palate will not achieve competent closure of the isthmus. An operation to bring the posterior wall of the pharynx forward and at the same time, to narrow the lateral dimension of the pharynx is required.

Wilfred Hynes of Sheffield showed us that this could be done. His pharyngoplasty (Hynes 1950) is another admirable application of basic plastic surgery principles. . . . The flaps should, however, be as thick as possible. . . . Hynes at first thought his pharyngoplasty ought to be introduced in the primary repair of clefts in young children, but I am sure that this is not necessary. The soft palate makes contact with the pharynx at a very high level in young children and I doubt if the Hynes pharyngoplasty eminence can be placed high enough to be effective in such young patients. . . . The Hynes operation works well only when the palate is effectively elongated.

Like a number of other surgeons, I have always felt that the shelf created by this pharyngoplasty would tend to flatten appreciably in time. In fact, some would say it had as much chance of standing up for any length of time as a sand castle against the incoming tide. This assessment was more true of the original design and less true after Hynes thickened his flaps and almost tubed them to each other. The additional advantage of reduction of the lateral pharyngeal recesses must not be discounted.

**CONSTRUCTING A SPHINCTERIC MEMBRANE**

Another intriguing use of the posterior pillar flaps has been developed by Miguel Orticochea, of pure Basque descent, born in
Montevideo, Uruguay, trained by Pitanguy in Rio and now running on "his own motor" in Bogotá. In 1970, in the *British Journal of Plastic Surgery*, Orticochea reported that for 11 years he had been closing the palate by simple approximation with sutures at 2 years of age. Six months later, at 2½, he cut the posterior pillars of the fauces, carrying the total palatopharyngeus muscles as two long rectangular flaps with superior bases. An inferiorly based pharyngeal flap, 1 × 2 cm., was elevated at the level of the tonsil, and the two pillar flaps were stitched side by side to the pharyngeal flap with U sutures. He compared this palatopharyngeus muscle transplant to the various muscle transplants effective in the hand and foot. Evolution of this sphincter over the next few months closed off the lateral spaces, resulting in a dilating-contracting circular hole, like the "diaphragm of a camera." Orticochea claimed that this sphincter in the membrane develops better, the younger the patient is at the time of the operation. He also stated:

Nevertheless, all the patients who presented with open rhinolalia before surgery, improved to a greater or lesser degree with the construction of the sphincter.

The vagueness of his report prompted me to quiz Orticochea during his "sphincteric" lecture to my residents in Miami in 1971. As he speaks little English, his presentation was interpreted by a capable Spanish-speaking E.N.T. resident. This situation, along with Orticochea's tendency to use such words as *all*, *always* and *never*, introduced a number of uncontrollable variables. Our discussion went as follows:

My first question:

"Miguel, do you always use this operation on all of your palates?"

"Yes. Ninety percent of Latin Americans with cleft palate have velopharyngeal incompetence. During 17 years of my practice in cleft lip and palate work, I have seen only two cases of direct suturing of the palate which functioned with competence, one in Buenos Aires and one in Bogotá. The Spanish language has only three nasal phonetics and the Latin American palates *all* are short with wide nasopharyngeal apertures. For this reason I use this sphincteric procedure in *all* cases. In certain cases when the flaps will
not reach, then the operation is done in two stages. If I lived in the United States, then I would use this operation only on incompetent cases.”

“Do you ever have failure of closure in the lateral holes?”

“Never! They are always closed in a few weeks.”

“Does fluid collect in the shelf behind your sphincter?”

“No, because the motion of the sphincter prevents the collection of fluid.”

“Does this affect tonsillectomy?”

“The tonsils can be removed at any time.”

“Here is an important case,” he emphasized, as a slide was projected of a palate with velopharyngeal incompetence in which the patient was saying “ah.” The posterior pillars of the fauces could be seen trying valiantly to make parallel approximation to each other but with a centimeter of failure. My final question:

“What is your percentage of good speech results?”

“That is difficult to answer. I have no statistics.”

It should be noted that Ortichochea is an active and exciting innovator. Although I have found several of his ideas lacking in principle, there are some that have been important and have started a new trend (musculocutaneous flap). His variation in the use of bilateral pillar flaps sparked other modifications.

Amiable Heinz Reichert of Stuttgart, in the *Journal of Maxillofacial Surgery*, 1974, described a lateral velopharyngoplasty which he feels is an improvement over the Orticochea procedure, both in principle and in technique. He explains concisely:

Using a Z-plasty, the lateral base of the pharyngopalatine arch is swung over upwardly and inwardly in exchange for a mucosal flap from the posterior pharyngeal wall. The palatopharyngeal muscle is thus transformed into an oval muscle sphincter, which actively closes the nasopharynx . . . The application of the principles of Z-plasty ensures that no raw surfaces remain postoperatively, and that healing occurs fast and without complication.
Reichert reported having used this procedure with success in three patients, noting that indication for the operation was limited to secondary scarred palates with poorly developed muscles.

Angel Heller of the Dentistry National University of Cordoba, Argentina, trained by Schuchardt, presented a modification of the pharyngoplasty of Orticochea in the 1975 *Journal of Maxillofacial Surgery*. He had found that in the Orticochea pharyngoplasty the sphincter closure showed a tendency to form a circular opening, the lumen of which was not always narrowed in sound function. Heller’s variation developed bilateral palatopharyngeal flaps, based superiorly, which are cut from the posterior pillars. A transverse incision in the posterior pharyngeal wall made it possible to dissect a pocket. The two dangling palatopharyngeal flaps, with their mucosal surfaces back to back, were tucked into the pocket with a mattress suture. Thus, velar closure was achieved in an anteroposterior direction by a transverse closure so that a sphincter action could be more effective.

Since 1968 Heller has performed 22 of these pharyngoplasties with his “crossed” palatopharyngeal flaps. He noted:

1. The double flap takes well in the surgical pocket where it is placed.
2. It is an easily performed technique with rapid, uncomplicated healing.
3. An active muscular closure is achieved during speech, with positive intrabuccal pressure.
4. The sphincteric closure is effective during deglution, even when the flaps do not contain enough muscular fibres.
5. The nasopharyngeal closure may be perfect with a positive intranasal pressure and permits a free flow of air during muscular relaxation, which as
a result of the type of flap and its "scissors" mechanism, facilitates nasal secretion flow.

6. Even when dynamic muscular activity is not achieved in the secondary palatoplasties, the intercrossing of flaps proves to be an effective sphincteric closure.

In 1977, in *Plastic and Reconstructive Surgery*, Ian Jackson and John Silverton of Canniesburn Hospital, Glasgow, presented their modification of Orticochea’s operation as a secondary procedure. Two lateral flaps of postfaucial pillars, including the underlying palatopharyngeus muscles, were cut free, sutured to each other end on end and then tucked under a wide, superiorly based pharyngeal flap to create a very bulky transverse roll on the posterior pharyngeal wall.

Of 100 cases, 74 have had at least one year follow-up, and speech results were reported to be 90 percent improved: 47 percent with no nasal escape; 23 percent with hyponasal speech at 3 months but none at 1 year; 4 percent with persistent hyponasal speech. In the six cases which had failed with the conventional pharyngeal flap, all showed improvement. Advantages of this sphincter pharyngoplasty were: (1) easy procedure, (2) velum not disturbed, (3) shrinkage less with contracture merely reducing the heart-shaped V.P. aperture, (4) less tethering during maxillary advancement, and (5) secondary adjustments possible.
40. Search for Dynamic Pharyngeal Flaps

Standard pharyngeal flaps offer various passive advantages to an incompetent velopharyngeal sphincter. They act as a posterior velar tether and tractor, offer their substance as an obturator and, with donor area closure, reduce the size of the pharyngeal aperture.

There were surgeons who were concerned about violating the posterior pharyngeal wall musculature. Randell Champion of Manchester, England, for instance, wrote in 1957:

The pharyngeal muscles should be left undisturbed, as much as possible and if a pharyngoplasty operation is undertaken, the mucous membrane only should be used.

This, of course, removed any slight chance of flap contractile ability. Almost as long as pharyngeal flaps have been in use, surgeons have enjoyed wishful thinking that the constrictor muscle fibers, usually incorporated in these flaps, were capable of full cooperation and active contraction to lift the velum toward the pharyngeal wall during speech.

In 1959 Broadbent and Swinyard postulated that the pharyngeal flap is a dynamic structure, as demonstrated by electromyographic findings in patients in whom either superiorly or inferiorly based pharyngeal flaps had been used. By means of monopolar EMG needles inserted through the palate in the area of the flap, they observed normal motor unit potentials during swallowing. In 1972 Fára and Vele reported their EMG findings in a large series of inferiorly and superiorly based pharyngeal flaps.
Inferiorly based flaps tended to preserve their nerve supply and therefore their EMG activity, whereas superiorly based flaps were likely to become denervated.

In 1971 Smith and Dedo, in dog dissections, found the nerve supply to the superior pharyngeal constrictor muscles. It enters at the midpoint of the lateral margin and thus would be divided during the development of any vertical pharyngeal flap whether the base was superior or inferior. In 1972 Owsley, Creech and Dedo performed clinical EMG studies in the operating room on anesthetized patients undergoing superiorly based pharyngeal flap operations. They concluded that the findings in humans and in dogs were similar:

After both lateral incisions and division of the inferior end of the flap had been completed, the flap was elevated. Following this, we were unable to demonstrate any EMG potentials at any location in the flap.

Then there was the minor matter of muscle fiber direction. Weber, Jobe and Chase noted in 1970:

Dynamic muscular contracture is also said to occur in pharyngeal flaps. . . . Since the muscle fibers are aligned transversely, it seems unlikely that contraction of the muscle would shorten the flap.

**THE INNERVATED CHEVRON FLAP**

Fred McCoy and Carroll Zahorsky of the University of Missouri School of Medicine, Kansas City, became interested in the possible dynamic action of the posterior pharyngeal flap. In an attempt to duplicate the 1959 electromyographic studies by Broadbent and Swinyard, which had indicated dynamic pharyngeal flaps with potentially functioning muscle, they tested their own pharyngeal flaps, taking elaborate precautions to avoid stimulation to any musculature adjacent to the flaps. They stated:

Contractility was not demonstrated in any of the patients we tested.

Their subsequent dissection of five cadavers to determine the exact pathways of innervation led to their 1972 design of a new type of pharyngeal flap, presented in *Plastic and Reconstructive Surgery*. This is their anatomical report:
Entering the skull, the vagus and glossopharyngeal nerves were identified as they emerged from the medulla and passed through the jugular foramen, along with the internal carotid artery. At this point, small branches from IX and from the ganglion nodosum joined a single branch from the vagus to form a branch which descended first, then turned medially and upward, paralleling the oblique fibers of the constrictor muscle. The level at which this major recurrent branching consistently occurred was about one or two centimeters above the level of the greater cornu of the hyoid bone. This branch supplied the middle and superior constrictor muscles.

In their course, these paired nerves passed downward in an extremely lateral position deep to the musculature, then turned abruptly medially and upward in a recurrent pattern to enter the deep surface of the muscles.

They deduced:

It seems apparent that the incisions for all the conventional pharyngeal flaps would completely sever this nerve supply, particularly the incisions for those flaps based superiorly. There is a possibility that an inferiorly-based flap, placed high enough, might retain some functioning neuromuscular units.

McCoy is a big-game hunter with trophies of polar bear from the Arctic, elk from the Rockies and elephant from Tanzania. He now feels that use of the dwindling numbers of fascinating species should be restricted to the shooting of specimens for museum collections, where the lessons of ethology can be best taught—possibly for the eventual survival of civilization. Here McCoy, with the shoulder patch insignia of the Kansas City Museum of History and Science, is preparing to measure an impala prior to mounting for the Museum.

Whether he is hunting bobwhite or bobcat, the same instincts that prompt McCoy’s charting of direction during a tracking, taking into account specific wind and terrain factors, must have led him, in his hunt for a dynamic pharyngeal flap, to shift the direction of its axis to a transverse chevron-shaped bipedicle flap:

The incisions are made through the mucosa and musculature, and the flap is elevated carefully from the prevertebral fascia to avoid damage to the nerve supply, just deep to the muscle.

An area of 8 to 10 mm. of the mucosa at the apex is denuded to allow its insertion under a flap on the nasal surface of the soft palate. This latter 1 cm. flap is based posteriorly and is raised just 1 cm. anterior to the posterior border of the soft palate.
The chevron flap is then pulled into position so that the two raw surfaces directly overlie one another. The 3 layers are then fixed with 5 through-and-through chromic catgut sutures. The donor defect can only be partially closed by undermining an advancement of the wound edges. The remaining defect heals secondarily without difficulty within 10 to 14 days.

At the time of the 1972 presentation, McCoy and Zahorsky had used this flap on five secondary cleft palate patients over a six-month period. All five showed an improvement, and one showed functional neurovascular components within the pedicles when tested electromyographically. In spite of the limited experience, these advantages were outlined:

1. A chevron-shaped, bipedicled flap, properly placed, can produce a dynamic neurovascular unit.
2. The two-directional pull, or "bridle effect," gives added effectiveness to the velopharyngeal closure.
3. The double pedicle fills twice the space filled by a single-pedicled flap.
4. There is a more natural central nasopharyngeal opening for mucous drainage.
5. There is no damage to that portion of the superior constrictor muscle involved in Passavant's ridge formation.
6. It may be possible to secondarily use this flap following the use of an inadequate superiorly-based flap.

In 1976 McCoy summarized his present stand:

Our development of this flap stemmed from our basic concern for the possible importance of a dynamically functioning pharyngeal flap. We shared Ray Broadbent's concept that dynamism is a highly desirable feature. We did not share his confidence that this was being obtained in his superiorly
based flaps. The same objections applied to those based inferiorly. Our
suspicion was confirmed by anatomical dissections. . . . Actually, once the
anatomical distribution of the nerve supply had been identified, the chevron
flap virtually designed itself. Since 1971, we have used the chevron flap
almost exclusively, with only an occasional superiorly based flap being used
for comparison. Our speech therapists have been enthusiastic from the
outset about the improved results, which in many instances were dramatic.

We are currently engaged in a five-year re-evaluation, not only of the
improvement of the quality in speech, but also of the question of dynamism
on these flaps. We have now done approximately 60 chevron flaps and
continue to do them exactly as originally described. The complications have
been rare and the two technical failures were probably due to the inexperi­
ence of the resident operators. Like most other pharyngeal flaps, we feel they
should be done at an early age, preferably under 6, and have been least
effective in patients over 16.

In 1973 in Plastic and Reconstructive Surgery Donald I. Kape­
tansky of Southfield, Michigan, reported his bilateral transverse
pharyngeal flaps for velopharyngeal incompetence. This proce­
dure, he explained, was developed to preserve the muscular
function in healed pharyngeal flaps as he had noted gradual
atrophy in “our series of 225 pharyngeal flaps during the past 14
years.” The operation was designed to produce two smaller
competent pharyngeal sphincters, in place of the single large
incompetent sphincter. His description of the method is clear:

A wide S-shaped incision is made on the posterior pharyngeal wall to
produce two flaps, each having a base of 15 to 20 mm with a length of 30
to 35 mm. The incisions are deepened to the prevertebral fascia (to preserve
any nerve supply entering on the deep aspect of the muscle tissue [McCoy
and Zahorsky]).
Usually the flaps can be inserted into the posterior 15 to 20 mm of the midportion of the soft palate. One flap is brought up to the nasal aspect—where it is turned on its long axis and fastened in place with interrupted, braided, non-absorbable sutures. The opposite flap is brought up to cover the oral aspect in the same position. A few interrupted sutures are used then to bring the two flaps together in the posterior midline area.

The residual defect in the posterior pharyngeal wall is closed with a few sutures which also pick up the deep fascia to avoid tenting of the tissues.

At the time of this first publication, Kapetansky had used double flaps on 21 patients over the preceding year.

By 1975 he had carried out 48 double-pedicle posterior pharyngeal flaps in patients ranging from 5 to 30 years. Thirty-nine had not had a pharyngeal flap before, but nine had had either an inferiorly or a superiorly based flap which failed to produce acceptable speech. One double flap separated, but dramatic improvement in speech was noted in the remaining 47 patients.

In his 1975 report in the *Cleft Palate Journal*, Kapetansky presented rough sketches showing (A) an incompetent palato-pharyngeal sphincter, (B) the formation of two sphincters with his double-pedicle procedure, (C) partial sphincter functioning during speech and (D) complete sphincter functioning during speech and swallowing.

He emphasized that the preservation of the nerve supply not only maintained a larger flap mass for better obturator effect but enhanced the flap’s contractile possibilities.

In 1975 Kapetansky forwarded to me three different problem cases of rhinolalia which had been completely corrected with his transverse pharyngeal flap operation:

A. W. M.—Nine-year-old male born with a cleft of the palate, poste-alveolar, with repair at eighteen months of age by another surgeon. In 1969, a vertical pharyngeal flap was performed by myself with incomplete im-
Improvement in speech. The patient then moved to Kentucky and the palate flap was transected by the plastic surgeon at St. Joseph's Hospital in Lexington, Kentucky, in 1970. Speech regressed completely. Tonsils and adenoids were removed in October of 1974. On January 30, 1975, bilateral pharyngeal flaps were performed without crossing the mid-line scarring of the posterior pharyngeal wall.

B. Before B. After

B. S. A. S.—Seven-year-old male with a submucous cleft palate. The patient had undergone tonsillectomy and adenoidectomy, and nasality of speech was severe. On February 3, 1975, I performed bilateral transverse pharyngeal flaps.

C. Before C. After

C. D. W.—Sixteen-year-old female born with a cleft palate, post-alveolar. At two years of age the entire palate was repaired in Ann Arbor. Examination showed a splitting of the uvula and a residual cleft at the junction of the soft and hard palate. There was marked nasality of the speech. On February 7, 1975, the palate was repaired with transverse pharyngeal flaps.

IS IT WORTH IT?

It is difficult to estimate how important dynamic action of the muscular portion of a pharyngeal flap is. Preservation of nerve supply is always ideal and will probably maintain better mass. Whether what muscle contractions persist will have any real effect on the complex and delicate speech mechanism is yet to be determined.

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FRANTIŠEK Burian, the tiniest giant in plastic surgery, was short in stature and in his later years, when I knew him, kyphotic. Yet his pioneering courage and fiery spirit made him stand tall among his peers. Because he was walled off from the rest of the world by the Iron Curtain, it was not until the middle 60’s that the free world began to discover his depth of experience. Finally allowed to venture from behind the Iron Curtain, he was always accompanied by a communist colleague-watchdog. At the Stockholm Congress he confided on the sly to his free world cronies, including Ivy, two months his senior:

Now for a few days, I have emerged into the sunshine; tomorrow I return to the darkness.

At the Plastic Surgery Clinic in Prague, it was revealed that he had been using primary pharyngeal flaps since 1924. In his 1964 Gillies Memorial Lecture, he reviewed his 40 years of experience:
I postponed lip operations till the fifth month or even later, and palate operations till the fifth year. To prevent the collapse of the arch of maxilla, I interposed a flap of upper lip mucosa between the poles of the bone cleft. The palate operation consists of retroposition using the method of Kilner-Wardill, and fixation of the palate by means of pharyngeal flap with a superior pedicle.


Burian was indeed a pioneer of plastic surgery, and Fára has given me this little anecdote which perhaps with some paraphrasing paints his personality with color:

Whenever a fly was discovered in Professor Burian's operating theatre, it invariably caused great shock, stimulating extensive effort to kill it. During one such exciting incident, a simple woman in charge of cleaning spied a fly sitting on Professor Burian's shoulder while he was operating. With enthusiastic eagerness, she leapt up and swatted the fly with a great wet cloth! Everyone stirred uneasily. Burian looked slowly up at his assistant surgeon and asked calmly:
“Malice or stupidity?”
His assistant answered:
“Stupidity.”
and the operation continued. Following the surgery, Burian consoled the weeping, apologizing cleaning woman:

“Do not worry, you showed us that you know about antisepsis. After all, the head nurse is responsible and never should have let the fly in in the first place.”

In 1970 M. Fára, with E. Sedláčková, O. Klásková, J. Hrivnáková, A. Chmelová and I. Šupáček, reported that Burian, at the Prague clinic, had done his first primary pharyngofixation 46 years before and had been so impressed with the speech results and the reduced need for corrective operations that this procedure became routine. Of 2,689 primary palate operations, 2,073 were combined pharyngofixation. The technique involved a Kilner-Wardill type of V-Y retropositioning of the palate with the release in the nasal mucosa just posterior to the edge of the hard palate. Into the nasal defect the tip of a superiorly based, sometimes tubed, pharyngeal flap was sutured partially to line the nasal side and to fix the pushback with the pharyngeal flap.

Fára noted the two instances in which the pharyngofixation was not used:

(1) where the morphological and functional conditions are exceptionally favorable, and perfect velopharyngeal closure after simple retroposition can be expected; (2) in mentally defective children, where speech has no social importance.
Fára concluded:

The follow-up of our patients has shown that speech results, however great the retroposition, are much better in patients:
(1) with (rather than without) pharyngofixation, (2) with primary (rather than secondary) pharyngofixation, and (3) with upper-based (rather than lower-based) flaps.

In 1972 Miroslav Fára with František Vele again presented the adjunct of tubing the superiorly based pharyngeal flap using its distal, opened portion, not unlike a blooming morning glory, for attachment to the anterior nasal side of the soft palate. They concluded that the quicker healing and reducing seen after tubing or closing the proximal aspect of the superiorly-based flap assists somewhat in preservation of the muscle fibers.

It was noted that, because the Czech language demands a high standard of palatopharyngeal closure, this flap contributes considerably to the good results of this cleft palate therapy.

MARINO

The intellectual, articulate and enthusiastic Hector Marino of Buenos Aires, Argentina, in 1942 was the first to write a comprehensive book on cleft lip and palate in the Spanish language. In 1949 he presented his idea of combining the pushback operation with the standard pharyngeal flap and published it in the Bulletin of the Argentine Academy of Surgery. In 1972 he wrote:

I recall how I came to perform the first case. In March, 1947, I had been lecturing in Brazil and decided to visit the beautiful old town of Ouro Preto which lies near Belo Horizonte. Upon arrival, I went to visit the professor of otolaryngology at the University and, upon handing him my card, found that he already knew me. It happened that he had a niece with a cleft palate who had been operated a number of times and without much success. He informed me that this niece was about to leave the next day for Buenos Aires to consult a Dr. Marino. You can imagine what followed: an immediate visit with the patient and a splendid stay in Belo Horizonte. Well, the poor girl was a sorry mess, one of those scarred palates with a long, long velopharyngeal gap. Anyway, she came to Buenos Aires and I combined the pushback operation with an inferiorly-based pharyngeal flap. The operation was a complete anatomic and functional success (perhaps beginner’s luck?!).
I had shelved the idea until one day in December, 1947, Drs. Gustav Aufricht and Jerome Webster, who had been to the IV Latin American Congress held in Montevideo, visited my office. I happened to see my Brazilian girl in the waiting room and showed her to my friends. Their reaction was most rewarding, as they admitted never having seen this combination done before. Coming from such a learned man as J. P. W., I realized the idea had some value and decided to publish it. But as nihil novum sub sole, I must say that, later on, I met in Spain a famous pediatric surgeon, Dr. Rovilarta of Barcelona, who I believe had the same idea more or less at the same time as myself.

Then one day, during the First Congress of Plastic Surgery (Stockholm, 1955), somebody spoke at length on this procedure and claimed priority for it. To everyone’s surprise, Jerome Webster asked to come to the podium and, pointing to me, said that he believed there was the originator of the procedure and went on to tell about his visit to my office in Buenos Aires.

In 1950, in the British Journal of Plastic Surgery, Marino, with Renato Segre, advocated pharyngostaphyline fixation as a complement to the pushback operation. A Dorrance-type pushback with the nasal surface of the mucoperiosteum lined with a skin graft was held in backward position by the attachment of a thick, inferiorly based pharyngeal flap to the sutured posterior border of the velum. The union was filled with two layers of sutures. The authors noted:

The procedure guarantees against the loss of some of the backward displacement of very short palates, which happens quite often even with a correctly executed push-back operation.

They did not hesitate to dispense with this adjunct, if advisable:
We have observed in some cases that the results of re-education reached a not superable limit which was far from ideal. This was attributed to the rigidity imposed on the velum by the pharyngo-staphyline fixation. To go beyond this limit, it is felt that the union of the velum to the pharyngeal wall must be divided as soon as the anchoring effect on the push-back is no longer needed, and the reabsorption of scar tissue ends. This simple procedure is performed within two or three months of the attachment to the pharyngeal wall.

SANVERO-ROSSELLI

In 1954 Sanverno-Rosselli, at the First Hamburg Cleft Palate Symposium, proposed an extended use of his superiorly based flap to fill the nasal defect, following a releasing division of the nasal mucosa from the posterior edge of the hard palate in the primary operation, as presented by Honig in these sketches at the Second Hamburg Symposium:

According to C. A. Honig of Utrecht, the Netherlands, this technique of V-Y retropositioning, in combination with division of the nasal mucosa along the edge of the hard palate and the filling of this nasal defect with a superiorly based pharyngeal flap was not published.

In his 1963 thesis "On Pharyngoplasty" Honig summarized at the 1964 Hamburg Symposium:

We have investigated the functional and anatomical results obtained by this operation in 48 patients. All of these had previously undergone one or more operations for cleft-palate and all had unintelligible speech and defective closure mechanism, as observed through the open mouth prior to pharyngoplasty.
The competence of the reconstructed velopharyngeal closure mechanism was judged from contrast X-ray pharyngograms and from function tests. A sufficient closure mechanism was found in 42 of the 48 cases... and bad in 3.

This operation seems to be more extensive than the short releases and the narrower flap used by Burian, who also indeed used the pharyngeal flap for at least some nasal lining.

**CONWAY**

In 1951 Herbert Conway at Cornell Medical Center combined the pharyngeal flap with V-Y pushback operation. In 1955, at the Stockholm Congress, Conway, with Stark, elaborated on the importance of the inferiorly based flap in secondary cleft palate correction.

Conway had done some boxing in his youth and remained a dangerous infighter all his life. I enjoyed him and his con-artistry, once accusing him of being a crafty "old pro" with his ability "to hang on and hook" in close. He admitted to this attribute, and the drawings presented by him and Stark in the Stockholm 1957 Congress *Transactions* were examples of this art.

In fine tone drawings, they showed the original relationships with a velopharyngeal distance of 2.5 cm. Then, following a V-Y retropositioning aided by the Limberg osteotomy (which Conway...
favored) and the attachment at the uvula of an inferiorly based pharyngeal flap, they presented the velopharyngeal distance reduced to 1 cm.

CHASE AND OTHERS

The same clever, two-in-one method of using the pharyngeal flap, both as a retracting suspension and as a mucosal cover to the raw nasal area, was developed independently by Robert A. Chase, professor of surgery, Stanford University, and reported in 1965 by Dibbell, Laub, Jobe and Chase. In 1976 I wrote the first author, David G. Dibbell, now at the University of Wisconsin, Madison, about this work and about his former chief. He answered:

I was a very junior member of the team at the time the paper was published. . . . One thing that does come to mind about Chase: after he was made the Chairman of the Department of Surgery at Stanford University, when formally asked the nature of his profession, he would respond, not that he was a plastic surgeon or a surgeon, but that he was a medical educator. Obviously, his history from that time on has demonstrated that this objective has provided him with his main driving force.

In 1977 Bob Chase was requested to reminisce about this pharyngeal work. He wrote:

In surgery, as in life, a thorough familiarity with principles is the key. Imagination and curiosity coupled with a knowledge of principles has been the cause for turbulence between surgeons on the question—who should be credited with a new idea, operation, or technical wrinkle? It should be no surprise that individuals simultaneously or sequentially come up with the same ideas independently since most sensible ideas are based on fundamental principles.

For years there has been discussion about the problem of scar contraction of the raw palate surface as a cause for restriction of the palate and return to its forward position after pushback surgery. It seemed sensible to suggest that one strategy for resurfacing the raw area on the nasal surface, while at the same time taking advantage of the other possible virtues of the pharyngeal flap, was to use this pedicle flap to cover the nasal raw surface. We tried it and found it a useful technique.

On preparing material for publication in the customary detailed literature search, I came across a little-referred-to thesis by C. A. Honig presented in 1963. Honig rightly credited Sanvenero-Rosselli with having demonstrated
the use of the superiorly-based pharyngeal flap on the nasal side of the soft palate at a meeting in 1954. Honig's modification of the Sanvenero-Rosselli procedure is very similar to that described in our paper of 1965.

Far from being disappointed or embarrassed, I was delighted to see that the principle made sense to others and that their successes had borne out the good sense of application of those principles. It is not whose idea it is that is important but the fact of the idea itself that counts.

It comes down to fundamentals, and it does not take an intellectual giant to know that to be true. Take the good sense of Phil Esposito of hockey fame who, it is said, exhibited that sense in a recent T.V. interview. The interviewer, growing impatient with the general low key responsiveness of Esposito, said in desperation as the interview was drawing to a close,

"Come on, Phil, tell us what makes you such a great player?"
"Did your father motivate you as a child?"
"Was your uncle a great hockey player?"
"Do you do it for the overall team spirit and affection for your team mates?"

Esposito's answer, a classic putdown to this barrage of suggestions as to what makes him such a great hockey player, demonstrated his belief in fundamentals.

Said Esposito, "It helps a lot if you know how to skate."

In 1971, with Richard Yules, Chase re-endorsed this principle for secondary correction of palatopharyngeal incompetence and added:

This "secondary operative procedure" may provide an excellent primary procedure in select cases; if so, there is no contraindication to employing it before the child acquires poor speech habits.

Yules and Chase justified their approach with good reasoning:

An effective method is simply to attach the pharyngeal flap to the raw nasal surface, thereby preventing severe scar contracture both in the lengthened velum and in the free pharyngeal flap.

Chase prefers the more physiological superiorly based flap, concurring with the 1959 findings of Broadbent and Swinyard which demonstrated dynamism and electromyographic activity in these flaps. Thus Chase argued:

The philosophy on which we predicate our view is that the pharyngeal flap offers an opportunity to do more than anatomically occlude the velopharyngeal space; it may also provide help in elevating the soft palate for more effective closure.
Chase and Yules use a Dorrance or V-Y pushback, performing an osteotomy on the posterior wall of the posterior palatine foramen to facilitate retropositioning. With its base as cephalad as the atlas promontory, the pharyngeal flap is cut as wide as possible without impinging on the Eustachian tube orifices and long enough to reach the front of the cleft and line the raw nasal area. As they warned:

Care must be exercised to avoid injury to the ascending palatine arteries coursing on the posterior side of the pharyngeal wall approximately 1 cm. to either side of the median raphe.

They make no issue about primary closure of the pharyngeal donor area:

Some surgeons leave the defect unrepaired and allow it to heal by secondary intention, while others suture the margin of the defect together. Either method results in narrowing the palatopharyngeal isthmus, thus reducing the nasopharyngeal port.

In 1973 in the *British Journal of Plastic Surgery* Richard Jobe of Stanford University reported adjuncts to facilitate combining a pharyngeal flap with a palate pushback. He advocated determining the length of the pharyngeal flap by measuring the distance from the posterior edge of the hard palate to the posterior pharyngeal wall. Then, after injection of 0.5% lignocaine with 1:200,000 adrenalin in planned operative sites, he advised elevating the pharyngeal flap in a dry field before doing the palate pushback. He also described another trick:

It has been our practice to place a loose suture through the tip of the pharyngeal flap. When the palate dissection is complete, a small Robinson
urethral catheter is passed orally into the nasopharynx through the nasal defect of the pushback. The suture in the flap is then threaded through the holes of the catheter and the catheter is withdrawn. Traction on the suture then brings the flap on to the nasal surface of the palate, where it is secured.

Jobe, anxious to set the record straight, wrote in 1976:

One day in the late 1960's, while I was doing a pharyngeal flap pushback operation of the type invented by Sanvenero-Rosselli and popularized by us at Stanford with Douglas Ousterhout, I was deriding a recent resident graduate of Stanford, who had had a one-page paper in *Plastic and Reconstructive Surgery* of a technique clearly stolen from one of our consultants without reference. During this conversation and operation, Ousterhout suggested to me the use of a catheter to pull a pharyngeal flap around the backside of the released palate to simplify considerably this procedure, when the palate is not divided.

Daisey Stilwell illustrated this neat trick and it was accepted by the *British Journal of Plastic Surgery*, but I forgot about Ousterhout's involvement. When the paper came out, Ousterhout was quick to razz me about stealing his idea precisely at the time I was accusing another. I have apologized to Doug but would be more than delighted if this tale and my apology could be exposed.

E. N. Kaplan of Stanford University, in a 1973 follow-up clinical report, noted that an additional 125 combined pushback and pharyngeal flap cases had been performed. He reported an improvement in all cases, the improvement closely related with the adequacy of velar mobility. No patient was made worse, and those least improved had unilateral or bilateral complete palate paralysis. Kaplan noted:
We believe that the palate pushback enhances the capabilities of a mobile palate by positioning the palate closer to the pharyngeal wall; also, the pushback frees the levator muscles from their abnormal insertions on the unyielding surface of the hard palate. The pharyngeal flap lines the raw nasal surface of the pushed back palate, thus preventing wound contracture that would pull the soft palate forward toward its preoperative position.

In 1977 R. Dijkstra of Zwolle gave his arguments in favor of a superiorly based flap to fill the nasal defect in a pushback. He cited the expendable pharyngeal wall donor area, ease of surgery and narrowing of the pharynx.


Roland Minami of Greenbrae, California, threw a little sobering light on the lack of omnipotence of this or any palate procedure when he wrote in 1978:

My introduction to cleft palate surgery began during my first year of residency at Stanford, when an enthusiastic Chief Resident presented a girl
with severe hypernasal speech. She was 17 years old, mentally slow, had a sister and mother with hypernasal speech, and was suspected of mimicking them. "How are you, Miss Smith?" asked the Chief Resident. "Phhhhine!" replied the girl. The next day she had a palate pushback and pharyngeal flap which was then our standard operation for velopharyngeal incompetence. Sometime later, we were showing off examples of our plastic surgical prowess to the Chief of Surgery. Among them was the not-too-bright girl who had had the pushback and flap. The Chief Resident proudly introduced the patient and described her treatment. "How are you doing?" he asked brightly. "Phhhhine!" snorted the girl, just as she had done preoperatively.

At the time, we found this episode amusing in a morbid sort of way. However, I am sure that this scene has been repeated many times in plastic surgery centers all over the world, and it is not funny. It does serve to illustrate the insufficiently stressed fact that there are a multitude of factors unrelated to the palate which influence the choice of operation (or not to operate!) and the results that may be expected from such treatment. All hypernasal patients are not alike, and should not be approached in a standard fashion.

TAILORING OF THE FLAP

The Burian-Fára-Rosselli-Honig-Chase two-in-one principle has great appeal to the Scots strain in my ancestry. Yet this same stingy streak nudged me to save the waste of a long, wide flap by custom-fitting the design for the specific defect.

It so happened, one day in November of 1968, that three plastic VIP's, Jack Penn of Johannesburg, Jan Strombeck of Stockholm and Ross Musgrave of Pittsburgh, were crisscrossing at Miami International Airport, and the delay in flights allowed them a little time in our operating room at Jackson Memorial Hospital. A wide, unoperated adult cleft palate was scheduled, and the mouth was large enough for the "Big Three" to see an island flap being inset. As I lifted the mucoperiosteal flap on the first side, a meager, string-like anomalous structure represented the neurovascular bundle. This was dismissed as a possible carrier for the island.

An advantage of this method [I sighed, with beads of perspiration appearing] is that, should anything happen to one side, there is always the second side to supply the island.
The second side was like the first, and by this time I was sweating profusely, having already divided the soft from the hard palate. During an embarrassing silence, we all stared through the large elliptical hole in the nasal lining.

In desperation, it occurred to me that a pharyngeal flap based superiorly and of Chase's length could be shaped as a T and used to line accurately the entire nasal pushback defect as well as the anterior two-thirds of the soft palate cleft. The procedure went well, and Penn, at the end, allowed that "necessity is the mother of invention."

In spite of the width of the cleft, there was marked improvement in speech which could have been even more pronounced had the patient, who is a police radio operator, been willing to take time off from tracking crooks for speech therapy.

The method was published in *Plastic and Reconstructive Surgery* in 1970 with the accompanying diagrams.

Another T pharyngeal flap was used in a secondary lengthening of an operated complete cleft in a 13-year-old girl with nasal speech; she had a very short, scarred palate riddled with fistulae, rendering an island flap impractical. Five months after surgery, her speech had improved to such a degree that she won a school prize in speech and was given the lead in her class play. She can blow up a balloon for the first time, and her grimaces have almost completely disappeared.

This T pharyngeal flap has been used four times. The need is rare, but surgeons embracing this principle might find it of value. It allows a tailored closure of the nasal pushback defect at the same time it provides a suspensory synechia to maintain length. It takes tissue from outside the palate, and the eventual reduction in the pharyngeal vault is an extra advantage in speech. The base of the flap can be used in the nasal closure of the actual soft palate when this cleft is wide and requires extra tissue. The blood supply of the posterior pharyngeal wall, supplied by the ascending and descending pharyngeal vessels, is adequate to nourish the T. The prongs of the T need not be exactly transverse but can be directed obliquely to enhance the potential blood supply. Or, as Chase suggested when the T was offered to him: "Can we split the end of the flap?" The base should be of generous width and,
with the base placed superiorly, the T must be taken from well down on the pharyngeal wall to provide adequate flap length to reach the anterior defect at the posterior edge of the hard palate. This procedure calls for a bit more surgery than an island flap or even a routine pharyngeal flap, but when indicated, it can help to solve a difficult problem. It is available as a primary or a secondary procedure.

**FOR EXTRAORAL MUCOSA**

Australian Anthony J. Emmett, after training in plastic surgery with two Hawke Bay New Zealanders working in England, eventually returned to Brisbane. Here he is involved in various transplantations and modifications. On his farm he successfully transplanted 60 olive trees out of 400, and he is raising Braford cattle, a crossbreed of Brahma and Hereford, originally developed to flourish in Florida heat by my friends, the Alto Adams of Fort Pierce. In palate surgery he has modified the standard pharyngeal flap by taking a full-thickness flap of mucosa and muscle with a high, superior base and cutting it 2 to 3 cm. wide and 6 to 8 cm. long. The distal 1 to 2 cm. retains its mucosa while the next 5 to 6 mm. of the pedicle is carefully denuded, presenting a mucosal island with a raw neck which is passed through a transverse split in the palate and used for additional mucosa on the oral side. As he wrote in 1977:

This operation is indicated for the palate which is short and scarred where it is desired to put a flap of elastic pharyngeal mucosa into the oral surface of the palate at the junction of the hard and soft palate. . . . The flap can be brought through the palate by simply having divided the palate transversely to allow the soft palate to fall back. Generally we prefer to split the palate as well as divide it transversely.

**COMPARISON OF PHARYNGEAL FLAP INSERTIONS WITH OR WITHOUT PUSHBACK**

In 1977 at the Third International Cleft Palate Congress in Toronto, Michael Lewin, with Daniller, Croft and Shprintzen of
Montefiore Hospital, the Bronx, reported comparison of three different insertions of wide, superiorly based pharyngeal flaps in 100 patients observed over six months postoperatively with multiview videofluoroscopy and nasopharyngoscopy.

1. The U-shaped pushback (Dorrance) includes transverse division of the palatal aponeurosis and nasal mucosa with insertion of the distal one-fourth of a wide pharyngeal flap to line the nasal side (Sanvenero-Rosselli, Honig, Chase). The rest of the unlined pedicle suspended in the nasopharynx contracts into a tube.

2. The sandwich attachment splits the posterior edge of the soft palate horizontally above the uvula and extends laterally along the posterior pillars. Into this pocket is fitted a short, wide pharyngeal flap including its mucosa (Webster). Because of the width of attachment, the flap does not curl but contracts in an anteroposterior direction.

3. The soft palate is split three-fourths of its length. The nasal mucosa and the aponeurosis are divided from the hard palate, and the levator muscle is repositioned and sutured (Braithwaite). The pharyngeal flap is introduced into the longitudinal split on the nasal side with the uvula being sutured to the base of the pharyngeal flap to provide lining.

They summarized:

The closure of lateral gutters on phonation, which is essential for elimination of hypernasality depends primarily on the amplitude of LPW [lateral pharyngeal wall] movement. The latter is an important factor in predicting the success of the operation.

The unlined pharyngeal flap, combined with pushback [1], provides the least obturation. The sandwich flap [2] is highly effective but tends to over-obturate the nasopharynx and results in a high incidence of hyponasality. The pharyngeal flap, combined with splitting of the palate and recession of the velar musculature [3], is suited for a majority of patients with VPI. Its failures seem to be limited to patients with absence of LPW movement.

Donor area

The pharyngeal flaps in this comparative study took the entire
width of the posterior pharyngeal wall, and the donor area was closed except for "a small dime-shaped raw area" at the flap base. Primary closure was considered to reduce morbidity and minimize descent of the flap base by contracture. Lewin and his colleagues admitted, however:

Examining patients a few months after operation, we found no visible difference between those where the wound healed by contracture and those closed by suturing.
Complications and Failure of a Pharyngeal Flap and Its Secondary Surgery

Immediate postoperative complications are more common after posterior pharyngeal flap surgery than with the usual palatal cleft closure. Pharyngeal flaps can, of course, be used to relieve tension in the closure and so to reduce certain complications. Yet the invasion of the normal posterior pharyngeal wall and its musculature and the abnormal attachment of a flap, partially raw on its undersurface and spanning an open space to a needy but unsuspecting velum, are not without a price.

There have been fatalities. In 1886 Schoenborn reported 20 pharyngeal flaps with one death due to pneumonia. In 1929 W. Kindler reported four cases of pharyngeal flaps with one death due to mediastinitis. Rosenthal, Axhausen and others warned that pharyngoplasty should not be performed in the first 10 years of life. Numerous accounts of intraoperative and postoperative complications from pharyngoplasties in infants exist. Schröder in 1959, Skoog in 1965, Owsley in 1965, and others told of the necessity of tracheostomies. However, in 1968 W. Bethmann and H. J. Hochstein of the Rosenthal Clinic of Thallwitz, Leipzig, reported on 529 pharyngoplasties in an eight-year period in children of the average age of 7 years without a tracheostomy or death. They noted:

During work in the pharyngeal region, considerable changes of the heart rhythm sometimes occurred (sinus tachycardia, bradycardia, bigemina). . . . Sufficient premedication and depth of narcosis are of decisive importance.
Mortality is very low today because of improved anesthesia and postoperative recovery room care, but deaths can happen. Sudden hemorrhage and airway obstruction are the most likely causes. In 1970 Yules confirmed this when he stated that, excluding potential anesthesia risk, complications were most often related to severe bleeding—with or without associated airway obstruction—with mortality usually associated with pharyngeal flap surgery.

Hemorrhage is more common after use of pharyngeal flaps, and bleeding in this area is not only awkward to get at but dangerous to the airway. Prior to surgery, the nasopharyngeal aperture has been generous, and the sudden partial to near-complete obstruction of this air passage can cause anxiety, panic, straining and gasping, which in turn may start bleeding. The prime reason for suturing the flap's donor area, in my opinion, is its early hemostatic effect.

In 1966 Bengt Nylén and Åke Wahlin of Stockholm reported on airway complications of 103 pharyngeal flaps. They summarized:

There were 14 instances of postoperative complications (14% of the total group) and all were in connection with bleeding, which has also been important in other series. In 11 of the 14 cases the bleeding was checked by conservative measures or blood transfusions and did not cause concern, while in four tracheostomy had to be performed (with one death). We believe that the hemodynamic stress at extubation and laryngeal suction is due to reflex activation of sympathetic vasoconstrictor activity and venous blood congestion in the head and neck, in connection with coughing and straining and are the main causes of postoperative bleeding from a dry operative field. Extubation should therefore be planned with great care.

Yules and Chase, in the 1971 book *Cleft Lip and Palate*, list 18 groups using pharyngeal flaps with a complication ratio of about 10 percent. The compiled data of Nylén and Wahlin; Owsley, Lawson and Miller; Skoog; Edgerton; Smith, Huffman, Lierle and Moll; Walden and Rubin; Dunn; Moran; Williams and Woolhouse; Conway; Conway and Goulian; Stark and DeHaan; Gray and Jones; Champion; Longacre and DeStephano; Cox and Silverstein; Buchholz, Chase, Jobe and Smith; and Bernstein reveal a total of 1,149 pharyngeal flaps. In conjunction with them, there were recorded 3 hematomas, 19 respiratory difficulties, 15 tracheostomies, 37 flap detachments, 7 ear infections, 10 denasalities, 36 severe hemorrhages, 10 transfusions required.
With these findings in mind, Yules and Chase warned that for the first two days after surgery the patient must be watched very carefully for hemorrhage and respiratory obstruction. They noted that obstruction of the Eustachian tubes with mild otitis media was not uncommon and breakdown of the flap attachment was usually associated with bacterial infection. Even a fatality is a possibility which in the past exceeded 1 percent but has been reduced to about 0.3 percent. Single fatal cases of meningitis and mediastinitis have been reported.

In 1978, at the American Cleft Palate Association meeting, Bernard Borowiecki, Charles Pollak and Charles Croft of Montefiore Hospital, New York, commented:

A common finding in post-pharyngeal flap patients (children) is obstructive respiratory difficulty during sleep. . . . Some patients may continue to experience obstructive respiratory difficulty during sleep leading to development of obstructive apnea-hypersomnia syndrome and even death.

In 1973 Graham, Hamilton, Randall, Winchester and Stool noted that airway complications following the construction of posterior pharyngeal flaps were most frequent in children with micrognathia or other severe congenital anomalies. In the Pierre Robin syndrome, caution should be exercised before deciding to combine a pharyngeal flap and a palatal closure in one operation. An armored nasal tube may be useful postoperatively to ensure an adequate airway. These authors also advised that if tonsils are excessively large, particularly in small children, tonsillectomy be done at the time of the pharyngeal flap operation.

A painful “sore throat” and stiff neck are common complaints of the patients and have made this operation unpopular with me. Closure of the generous donor area under tension with large retention sutures or otherwise is seldom permanently successful and is responsible for the pain. Fára insists that muscle sutures will achieve permanent closure, but I have had 100 percent success. When the wound separates, it leaves a wide, messy granulating area which will eventually heal by contracture and epithelialization.

A certain number of flaps become detached. In this event immediate reattachment or delayed re-flapping is called for. Reports of detachment of the flap are scattered through the
literature, but many more cases, of course, are unreported. In 1960 Ross Musgrave and John Bremner of the University of Pittsburgh reviewed 780 cleft palate operations performed over a 10-year period, 1950–1959. They stated:

It is noteworthy that most of the 22 pharyngeal flaps that have been performed were secondary procedures for palates shortened by scar contracture of failed primary healing. Only one of the pharyngeal flap operations had any complications, this being detachment of the flap.

Pigott of Bristol tells of his pharyngeal mishap:

Once while teaching the houseman how to raise a pharyngeal flap and in getting the base really high using double-curved scissors out of sight above the soft palate, I amputated the flap completely! The patient, an intelligent young man, was a total success as the isthmus contracted down to a very small port which could open and close with perfection. Astley Cooper used to do this routinely, but I never dared do it again.

Finally, there are the insidious complications in the healing of the flap which render it ineffective. These include immobilization of the soft palate by incorrect positioning of the flap’s base for optimal velar action and simple flap contracture, dragging the velum down, frequently asymmetrically, to close only one port. There is also the rolling of a flap into a string tube with loss of its important obturator effect.

Pharyngeal flap reduction of velar mobility, for better or worse, is a fact. Joanne Subtelny, N. Oya, D. Subtelny, J. Curtin and R. McCormack in 1970 made a preoperative and postoperative analysis of velar and pharyngeal flap mobility. They asserted:

Despite the effectiveness of pharyngeal flap surgery, the results of this study indicate the technique generally does reduce velar mobility as reported by Skoog. Mobility of this flap is, however, significantly related to the extent of velar movement observed before surgery.

They also noted a reduction in the anterio-posterior aspect of the pharynx. As shorter pharyngeal dimensions have been identified with less nasality, the relative importance of the pharyngeal environment and its influence upon postoperative speech status is emphasized.
Karl S. Musgrave, in his 1971 master of science thesis at Eastman Dental Center and Graduate School of the University of Rochester, New York, reported his extensive cephalometric radiographic evaluation of pharyngeal flap surgery. Sixty postoperative pharyngeal flap cases were separated into successful and unsuccessful groups by nasality ratings. The comparative preoperative cephalometric data, which turned out to be 89 percent predictive of postoperative results, revealed that the non-nasal speakers had (1) greater elevational velar mobility resulting in a smaller palatopharyngeal opening, (2) a shorter nasopharyngeal depth and (3) a smaller nasopharyngeal area. These preoperative features, in addition to a younger age at the time of operation, suggested an important requisite in pharyngeal flap surgery's attaining a high-positioned pharyngeal flap base attachment with good elevational mobility, thus enhancing the pharyngeal flap mechanism for production of adequate velopharyngeal closure during speech.

In 1969 Richard Yules and Robert Chase reviewed the literature on pharyngeal flaps and concluded:

Although pharyngeal flap surgery has justified its popularity, the failure rates even as noted indicate refinements yet to be made in flap surgery. . . . Before the pharyngeal flap procedure can stand up on its own as a procedure of choice within a given cline of cine, speech, and respiratory study measurements, pre- and postoperative reliable measurements must be available. The present literature is remarkable for the relative absence of any such measures.

PHARYNGEAL FLAP
SECONDARY SURGERY

It is important to keep in mind that, despite what might be expected from the vast number of pharyngeal flaps being used today, this flap is not omnipotent or a cure-all. Skoog wrote:

A pharyngeal flap will not fully substitute for soft palate tissue in cases in which there is poor muscular function or a substantial deficiency of tissue. . . . It can be used to reconstruct a palatal membrane which will reduce nasal escape . . . but will not reproduce normal speech.
Barrett Brown of St. Louis was not an enthusiastic admirer of the posterior pharyngeal flap, but since he and his group were treating as many clefts as anyone else at that time, perhaps more, he did have occasion to use it sometimes. Frank McDowell informed me:

On rare occasions, Brown (and the rest of us) did a pharyngeal flap (secondarily) . . . usually by the method described by Padgett. Probably we did not do wide enough ones, or did something else wrong. Too often they seemed to coil up into a string or rope, which then acted as a tether to restrict movements of the velum.

Josh Jurkiewicz, one of Brown's residents, recalled:

Furthermore, he had little use for pharyngeal flap procedures and probably severed as many as any man alive. He saw a lot of failures after pharyngeal flap procedures, which at that time were simple attenuated tubed flaps, and he merely took these down, all the while castigating the procedure and occasionally Earl Padgett.

Pharyngeal flaps often are called upon to correct the residual velopharyngeal incompetence following other surgical procedures. Although these flaps, with their obturation, tethering and pharyngeal narrowing, do assist and are usually responsible for improvement in speech, there are many pharyngeal flaps which fail to solve the incompetence. The gap may be too wide, the scarring of the velum too extensive, the pharyngeal flap too narrow or its base not set at the optimal position.

In 1972 and 1973 Leon Skolnick and Gerald McCall, using videofluoroscopy in multiple projections (lateral, frontal and basal), studied velopharyngeal competence and incompetence following pharyngeal flap surgery. They found

the incompetent velopharyngeal mechanisms to be attributable to abnormalities of (1) flap width relative to the extent of medial movement of the pharyngeal walls, (2) flap position in relation to the pharyngeal walls on the horizontal plane and (3) flap level vertically in the nasopharynx as related to the region of maximum medial pharyngeal wall movement. These abnormalities have been noted to result in incompetence of one or both portals lateral to the pharyngeal flap.

Such findings, especially in the presence of continued velopharyngeal incompetence and poor speech, require secondary pharyngeal flap surgery.

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John Q. Owsley, Jr., of the University of California, San Francisco, being born into a Navy family, naturally took to the sport of ocean racing, leaning his 6 foot 5 inch frame against all weather and winds. He also became the troubleshooter for failing pharyngeal flaps, investigating the causes of failure and prescribing the possible cure. In 1965, with Blackfield, he had emphasized the importance of maintaining an upward posterior vector of motion of the soft palate when attaching a pharyngeal flap. He noted the low pharyngeal flap which, when attached at the posterior margin of the soft palate, produces traction in an inferior or straight posterior direction and may actually restrict normal palatal elevation.

In 1972, with Brevator Creech and Herbert Dedo, Owsley said:

A significant number of patients with residual velopharyngeal incompetence after a pharyngeal flap operation have been found in our experience to have just this type of restrictive flap. Clinical and cinefluorographic examination of these patients suggest that the central pharyngeal flap acts as a static obturator. . . . If there is good palate mobility and pharyngeal muscle movement, many low attached pharyngeal flaps will provide non-nasal speech. However, if palate elevation is restricted and pharyngeal muscle activity is ineffective or easily fatigued, then hypernasal speech persists.

In the 1972 Cleft Palate Journal they presented drawings demonstrating restrained action in the presence of a restrictive pharyngeal flap: (A) at rest and (B) phonating "ah." Their recommendation was logical:
It therefore seems reasonable to suggest that poor speech due to a restrictive pharyngeal flap may be improved by division of the flap and reattachment of a new, high, anteriorly attached flap.

They divide the previous flap from the pharynx and suture the small defect in the pharynx. The soft palate is split, facilitating a view of the posterior pharyngeal wall, which appears unscarred in spite of its being the previous donor site. A new flap is cut with its superior base above the tubercle of the atlas. The recipient site is developed on the anterior nasal aspect of the soft palate by reflecting posteriorly based flaps of palate mucosa. After the pharyngeal flap is sutured into the recipient site, the mucosal flaps are used to line the raw undersurface of the pharyngeal flap and reduce inferior migration of the base of the flap again. No attempt is made to close the posterior pharyngeal donor area. The postoperative result in five patients was encouraging.

By 1976 Owsley, with Lucie Lawson and George Chierici, had had increased experience with the "re-do" pharyngeal flap:

Twelve patients with persistent hypernasal speech after a previous pharyngeal flap operation had a second pharyngeal flap operation performed by the high-attachment technique. Six of them achieved complete or near complete correction of hypernasality in connected speech. Four showed speech improvement of a lesser degree. Two patients had no significant improvement.

WEBER

In 1970 in the *British Journal of Plastic Surgery* Jaroy Weber, Jr., R. Jobe and R. Chase of Stanford University reported five patients with hypernasal speech resulting from low-lying, restrictive pharyngeal flaps. It is fortunate that Weber, with a trained ear and involved in American folk music playing the guitar, mandolin and banjo, should gravitate to palate surgery. These authors noted:

Superiorly based flaps . . . placed high in the posterior pharyngeal wall have augmented velopharyngeal function and have not appeared significantly to restrict palatal motion, either inferiorly or superiorly (Buchholz et al., 1967). Cinés of our patients after pharyngeal flaps have been indistinguishable from those of patients who have had pharyngeal flaps performed at the University
of California by the method described by Blackfield (Blackfield et al., 1963). . . Flaps placed low on the posterior pharyngeal wall, . . . have been felt to tether the palate in an inferior direction.

They acknowledge that migration in the postoperative period, a result of scar contracture between the flap and its bed on the pharyngeal wall, can affect the location and pull of the flap.

In defense of the Stanford method, they stated:

The importance of the site of the attachment of the pharyngeal flap to the palate has not been sufficiently emphasised. It is felt that the flap should be sutured at, or anterior to, the central insertion of the levators. This provides a surface for the raw nasal side of the palate over the levator insertion and thereby inhibits scar formation between the levators and the hard palate. . . . The increased superior motion of the palate due to the levators may also inhibit inferior migration of the flap origin on the post-pharyngeal wall.

Two of the five patients with restrictive pharyngeal flaps were improved by division of the flap and construction of a superiorly based flap in conjunction with the palate pushback.

**DIRECTION OF CONTRACTURE**

It is true that any raw area on the undersurface of a superiorly based flap will tend to pull the velum upward while its donor area is pulling downward. The opposite is true of an inferiorly based flap as the flap’s raw area pulls downward while the donor area pulls upward. These counteracting actions probably explain why postoperatively it is often difficult to determine whether the flap was based above or below.

Tord Skoog of Uppsala learned respect for the downward drag of the donor area of a superiorly based flap and designed a three-fingered pharyngeal flap. He folded the two lateral narrow flaps under the main flap to line the junction of the flap with the raw area on the pharynx in a gesture to interrupt the potential contracture web. It is possible that a longer transposed flap from one side alone could well block contracture. At least, this principle is a prophylactic step against a possible complication.
AUGMENTATION BY FLAPS

Bard Cosman and Arlene Falk of Columbia-Presbyterian Medical Center stated in 1975:

Nasality persists in a small but significant number of patients who have had a pharyngeal flap. In addition, nasality may recur long after doing an initially successful procedure.

The causes of such primary and secondary failures are probably faults in the relative size and/or positions of these nasopharyngeal obturators.

They noted three methods of repositioning the pharyngeal flap:

1. Weber's repositioning divides the tethering inferior base and attaches a new, superiorly based pharyngeal flap at a much higher level on the nasal surface of the velum. The new flap is raw on its undersurface.

2. In McEvitt's repositioning, the inferiorly based flap is converted to a superiorly based one.

3. Owsley's repositioning divides the old, inferiorly placed base and attaches a new superiorly based flap high on the palate using a hinged-back lining from the nasal surface of the palate.
Cosman described his augmentation of a failing posterior pharyngeal flap. First he turns two inferiorly based pharyngeal flaps back from the lateral posterior wall on either side of the present pharyngeal flap. Then he turns two matching mucosal flaps from the lateral oral side of the velum with their bases on the posterior edge of the palate. These four flaps are overlapped on each side to augment the inadequate center attachment and to reduce the lateral apertures.

In the 1976 *Cleft Palate Journal* Bernard Hirshowitz and Dahlia Bar-David of Haifa, Israel, endorsed Cosman’s principle of pharyngeal flap augmentation. They reported success in three cleft palates that had experienced failure with pharyngeal flaps. A secondary pharyngeal flap of maximal width and adequate length was based superiorly at the level of the previous flap. It was divided down the seam scar of the previous donor area, and each end of the double flap was tucked into a pocket split along each side of the posterior edge of the soft palate.
In 1977, again in the *Cleft Palate Journal*, the same Israeli team suggested another approach. They repositioned the base of superiorly based pharyngeal flaps, which had migrated inferiorly and which were associated with persistent hypernasality, with a V-Y upward advancement of the base. Relief of the downward tethering effect in four cases was followed by gratifying correction of hypernasality.

**ADDITIONAL TEFLO**

In 1972 H. S. Sturim and C. T. Jacob, Jr., of Brown University, advocated the supplemental injection of Teflon behind the posterior pharyngeal wall in patients in whom a pharyngeal flap had been unsuccessful.

**PHARYNGEAL FLAP’S SECONDARY EFFECT ON THE MAXILLA**

It is conceivable that the tethering of a pharyngeal flap attached to the velum could have some retracting effect on maxillary development. Certainly, a broad, unlined pharyngeal flap, used in an early primary cleft closure, with the subsequent contraction, has the best chance of transmitting backward pull on the growing maxilla. There is, however, little consistent confirmation of this influence in the literature to date.

In 1976 Robert Pearl and Ernest Kaplan of Stanford University Medical Center reviewed clinical and cephalometric records of 25 patients who had had a superiorly based pharyngeal flap.
with a palate pushback. Linear and angular cephalometric measurements of these children revealed no later growth retardation of
the face. There was an inherent tendency of the secondary palate
cleft, classic submucous clefts and occult submucous clefts to
demonstrate preoperatively a narrow SNA and SNB—but the
difference between these two angles (ANB) was normal.

In 1977 R. Bruce Ross of the Hospital for Sick Children,
Toronto, reported on 62 patients who had pharyngeal flaps
attached to the soft palate. Serial cephalometric radiographs, from
the time of operation for an average of 6.7 years (minimum, 3
years) from a mean age of 8.2 to a mean age of 14.9 years, were
matched with twice the number of controls of the same sex, cleft
type and age. He noted:

Several of the many growth measurements showed significant differences
between sample and control groups. The conclusion, however, was inescap­
able that pharyngeal flap surgery performed at these ages does not interfere
with maxillary growth.

In 1977 Roberta Pineda and J. Daniel Subtelny of Rochester,
New York, studied the effects of primary pharyngeal flap surgery
performed on 24 cleft palate individuals prior to the prepubertal
growth period. Two control groups were used for comparison—
28 non-cleft individuals and 18 cleft palates without a pharyngeal
flap. Comparable longitudinal cephalometric records indicated
that pharyngeal flap surgery has an effect on maxillary growth. When
compared with the normal sample, both cleft samples, with and without
pharyngeal flaps showed some reduction in forward maxillary growth.
However, the pharyngeal flap group showed significantly greater reduction
in maxillary forward growth.

Gaston Maillard of Lausanne, Switzerland, trained by Tessier,
Dufourmentel and a Maytag Fellow in Miami, has observed again
and again the impossibility of moving the maxilla forward after
osteotomy against the firm fixation of a pharyngeal flap. Only
after division or lengthening of the flap can the maxilla be
advanced, and, on this basis, he feels certain that early pharyngeal
flaps have a retracting effect on maxillary growth.
MAXILLARY ADVANCEMENT AND THE PHARYNGEAL FLAP

Paul Tessier of Paris, as an invited professor at the University of Pennsylvania, carried out two maxillary advancements in which posterior pharyngeal flap attachments had to be lengthened to allow the maxilla to come forward. Randall, at the time of surgery, suggested a method of lengthening the pharyngeal flap without dividing it but did not check with Tessier (there is some language barrier) to see whether he had used this procedure before. The method designed was utilized and then soon reported without mentioning the fact that Tessier was the surgeon. The publication, by resident Robert Ruberg, Peter Randall and Linton Whitaker, appeared in the March 1976 issue of Plastic and Reconstructive Surgery, presenting a logical lengthening of a previously existing posterior pharyngeal flap in order to preserve its attachment when maxillary advancement is necessary. Lateral relaxing incisions were made on either side of the base of the previous flap. The inferior portion of this strip was divided and the flap dissected upward, maintaining a superior base. The inferior portion was employed to line the underbelly of the upper portion as the flap was lengthened to allow maxillary advancement.

This publication infuriated Tessier, who had used the procedure before. In the September 1976 issue of Plastic and Reconstructive Surgery, Whitaker wrote an apology:

We neglected to mention that Dr. Paul Tessier was the operating surgeon on the two cases described in the article—though the idea of lengthening the flap was, insofar as we know, first conceived by Dr. Randall. We have done this procedure since on other patients.

Tessier was not appeased.

MAXILLARY ADVANCEMENT MAY REQUIRE PHARYNGEAL FLAP

At the Craniofacial Symposium at the University of California, Los Angeles, in 1977, S. A. Wolfe inquired of those who are advancing maxillae how many advancements were causing velopharyngeal incompetence. He reported:
Dr. Paul Tessier stated that in his series of about 150 LeFort III advancements, he recalled 5 or 6 who developed VPI which persisted and required pharyngeal flaps—and they were all Aperts, who generally have a submucous cleft.

Henry Kawamoto of UCLA said that in his own relatively small series of about 20 LeFort I advancements, 4 developed VPI requiring PPF.

These were all CL/CP patients who were borderline pre-op—and the surgery nudged them over into gross VPI.

Reed Dingman of the University of Michigan noted in a case appearing in this volume that LeFort III maxillary osteotomy produced velopharyngeal incompetence in a cleft lip and palate case with borderline speech. He used a pharyngeal flap to correct the problem.

Ian Jackson of Glasgow noted in 1977:

We are often presented with a young child with nasal escape who will require a later maxillary osteotomy. In a small portion of cases this osteotomy will cause a recurrence of his velopharyngeal incompetence. In these, if the escape is mild or moderate and the child can cope, the situation is left untreated until after the osteotomy. If escape is severe . . . then a pharyngoplasty is performed.

In 1977 Mary Anne Witzel and Ian R. Munro of the University of Toronto described a 16-year-old postoperative cleft lip and palate patient who, after his maxilla was advanced 10 mm. and rotated down 4 mm., revealed hypernasality. Six months later, a palatopharyngoplasty restored his speech. Later that same year, Witzel and Munro reported further study of the effect of maxillary advancement after osteotomy on articulation and velopharyngeal function in 61 osteotomies (LeFort I, LeFort III and others). When articulation was directly tied to malocclusion, they noted, there was improvement in articulation after osteotomy with correction of occlusion. Of 18 cleft lip and palate cases, hypernasality occurred in five following LeFort I. It was found that patients who revealed a borderline mechanism preoperatively generally developed hypernasality. Those who were borderline preoperatively and remained so after maxillary advancement had a Passavant’s ridge which evidently adapted by increasing its excursion.
V. Hodgepodge
CONGENITAL velopharyngeal incompetence has as its most important manifestation *hypernasal speech without a cleft of the velum*. On examination, often to the surprise of the surgeon, there is at first sight a normal-looking palate with good mobility of the velum. More careful scrutiny reveals that in action the velum does not reach to the posterior pharyngeal wall, either because of a short palate or because of an abnormal backward position of the posterior pharyngeal wall. Of the many possible causes of velopharyngeal incompetence, one can be submucous cleft palate; however, not all submucous clefts have velopharyngeal incompetence.

Surgeons of the nineteenth century generally considered the submucous cleft of the hard palate the cardinal cause of open nasal speech. Some surgeons of that era, however, including Billroth, Passavant, von Langenbeck and Wolff, were convinced that late, spontaneous closure of palate clefts was frequent, without or after incomplete or unsuccessful surgical intervention. Robert Ivy himself reported such a case.

SUBMUCOUS CLEFT PALATE

In 1825 P. J. Roux of Paris first called attention to submucous cleft palate. In his *Mémoire* he recorded that, in 1823, he had been consulted by a young girl who nasalized so badly that her
speech was unintelligible. She had a cleft of the posterior portion of the velum, and there was a faulty union of the osseous tissue of the hard palate under an intact mucosa.

In 1846 Demarquay exhibited a dissection in which there was a cleft of the velum and a cleft of the bony palate which was filled with fibrous tissue and covered with intact mucosa.

Henri P. J. Winters of Utrecht University considers Gustav Passavant the rightful claimant of priority for describing congenital velopharyngeal incompetence. In 1862 Passavant reported a young female patient with a cleft lip and a spontaneously healed small cleft in the soft palate who three years later revealed the velum closed but a broad, deep submucous cleft of the hard palate and open nasal speech:

She visibly could not bring the velum into contact with the posterior pharyngeal wall.

In 1865 Passavant reported a man with a submucous cleft of the hard palate, an intact velum, a small bifid uvula and heavy open nasal speech. Further evidence suggesting Passavant’s genuine insight into the true physiology is given by his 1865 use of “insufficienz” in characterizing open nasality in speech after surgical closure of clefts of the soft palate.

In 1864 von Langenbeck described three types of bony clefts with the mucosa intact: (1) cleft of the velum with bony palate almost entirely absent, (2) cleft of the velum and hard palate in which the fissure in the bony palate was more extensive than in the soft tissues and (3) cleft of the velum associated with a fine split in the midline or on either side of the vomer, again with mucosa intact.

In 1869 Notta reported an 11-year-old girl with cleft uvula and bony cleft to incisive foramen with mucosa intact, who spoke with a distinct nasal twang. In 1870 Ulysse Trélat recognized the association of anteroposterior brevity of the bony palate and notching of the palate bones but attributed the nasal intonation to the anteroposterior shortening and lateral narrowing of the hard palate.

Lermoyez in 1892 defined “l’insuffisance vélo-palatine,” or congenital velopharyngeal insufficiency, as a developmental disturbance with a healthy, mobile, normal-looking short velum
which was *always* associated with a submucous cleft of the posterior hard palate and a bifid uvula. Gutzmann in 1899 expressed doubts as to this invariable association. In 1893 Mears of Philadelphia was the first American to note this condition.

In 1907 Ricardo Borey of Barcelona devised an operation for correction of the deformity. It involved elliptical excision of one or two vertical sections of posterior pharyngeal wall and closure with a continuous mattress suture, as diagramed.

Adam Brown Kelly, chief of the Throat and Nose Clinic at Victoria Infirmary in Glasgow, Scotland, was described as being a combination of modesty, geniality and humanity who "always remained an unrepentant laryngologist." He reveled in research and was the first, in 1910, to coin the phrase *submucous cleft palate*. He made a very complete study of eight cases and 11 cases of what he described as muscular insufficiency of the palate, in which all 19 presented rhinolalia aperta. He also observed a further 18 submucous cleft patients with normal speech. Measuring and comparing the hard and soft palate and the nasopharyngeal opening of these and normal subjects, he decided that both the hard and soft palate were short in submucous clefts. Kelly published sketches to demonstrate the variety of missing portions of the posterior hard palate. He was also the first to acknowledge that there could be hypernasality in the absence of the stigmata of submucous cleft palate.
In 1922 and 1923 Miloslav Seeman of Prague contributed several papers on submucous clefts. In 1927 Alexander Limberg of Leningrad introduced the terms *fissura ossea occulta* for submucous cleft of the hard palate and *fissura muscularis occulta* for submucous cleft of the soft palate.

In 1933 George Dorrance of Philadelphia, in his description of submucous cleft palate, remarked that the bony deficiency in the posterior part of the bony palate could vary from a large V-shaped defect to a mere notch to no loss of bone at all. Even with no bony defect, Dorrance pointed to the submucous cleft in the muscular tissue and in the palatal aponeurosis. He observed that the palatal mucosa was always intact but the velum was pulled forward with marked shortening in the anteroposterior diameter of the palate. He presented a sketch from Karl Peter showing a split uvula and he noted that the insertions of the levator palatini muscles were displaced forward and thus were unable to raise the velum upward and backward to the desired point of contact with Passavant’s cushion for velopharyngeal closure.

In 1954 James Calnan, while at Oxford, wrote a learned treatise on submucous cleft palate. He noted the varying deficiency in the bone of the posterior edge of the hard palate, the mobile but markedly shortened velum and the bifid uvula. The absence of muscle union and of a median raphe down the midline of the velum presented a translucent zone seen in the mouth when a beam of light was flashed from above. During phonation, this area broadened owing to the pull of the tensor and levator muscles.

Calnan excised the submucous cleft in eight cases and reported lack of muscle union across the cleft or poorly developed muscle fibres which lack orientation lying in a matrix of fibrous tissue. Mucous glands may present between the muscle fibres.

By cineradiography, as described by Ardran and Tuckey in 1951, Calnan studied the submucous cleft palate during speech and found that the velum failed to occlude the nasopharyngeal isthmus when it should, but its mobility and degree of elevation were not markedly impaired. The failure seemed to depend on the shortness of the velum, but when the posterior pharyngeal wall came forward, the velum moved upward and occluded the aper-
ture at a much lower level than normal.

Calnan was quite dogmatic about treatment:

In our experience there is only one treatment for submucous clefts with rhinolalia and that is surgical excision of the submucous portion of the cleft and V-Y retroposition of the soft palate on the lines described by Kilner.

If normal speech does not develop in three months, speech therapy is begun. Out of 17 cases, 15 achieved normal speech. Of the two remaining cases, one was successfully treated with a Hynes pharyngoplasty and in the other a Hynes procedure was planned. Calnan’s stand on submucous cleft in infancy is of interest:

The correct time at which to treat patients with submucous cleft (as with obvious cleft palate) is at or about one year of age, before the development of speech. As has been mentioned, patients are not sent for treatment or diagnosis until much older. This is due to a failure of diagnosis which could be improved: all patients with cleft lip should receive a thorough examination of the palate. If a submucous cleft can be diagnosed with confidence, then the rational treatment is to excise the fibrous cleft and retropose the palate.

Six patients with this condition have been seen and treated in infancy in this Department. Four now have normal speech without the need for speech-training: the remaining two seem to be developing normal baby-talk.

In 1965 H. William Porterfield and John C. Trabue of Columbus, Ohio, endorsed Calnan’s classic triad of (1) bifid uvula, (2) midline soft palate muscle separation with intact mucosa and (3) midline notching in the posterior edge of the bony palate as prerequisites for diagnosis of submucous cleft palate. They reported 18 submucous cleft palate cases out of 505 cleft palate patients and made recommendations as to what to do:

In view of our experience of a delay in seeing these cases and inferior speech results, we advocate the following: (1) Recognition of this defect in early infancy by the initial examining physician. (2) Surgical repair at 16 to 18 months by the pushback technique.

DIAGNOSTIC AIDS

In 1966 several publications dealt with submucous cleft palate, paying special attention to diagnosis and its guide to surgery.
Previous techniques used for diagnosis of submucous cleft palate had ranged from Olin’s palpation of the bony defect to Van Riper’s use of radiography. Raymond Massengill, dedicated speech pathologist at Duke University, who raises roses and Tennessee walking horses, was stimulated in 1966 to devise a simple light instrument with an extension to be passed into the nostril and over the nasal side of the palate. The light penetration of the submucous cleft is studied by oral photometry with a photocell placed under the palate. Readings establish the extent of the submucous cleft. Variations of this overt diagnostic technique, presented in *Plastic and Reconstructive Surgery*, are used in many clinics today.

In 1967 Thomas Rees, D. Wood-Smith, C. Swinyard and J. Converse of New York University studied 12 submucous cleft palate cases with electromyography and diagramed the typical zone (dotted region) of absent to diminished electrical activity. They reported in *Plastic and Reconstructive Surgery*:

1. Electromyography is a useful diagnostic adjunct in the submucous cleft palate.
2. Electromyographic "mapping" of the muscle deficiency in the submucous cleft palate can serve as a guide to the surgeon in selecting the appropriate width of nonfunctioning soft palate to be excised.
3. The muscle deficiency present in the submucous cleft palate would seem to warrant the addition of muscle tissue as a component part of the repair. A pharyngeal flap helps to achieve this objective.

Indeed, their best speech results, they found, occurred in the two Veau-Wardill pushback operations with a superior pharyngeal flap added.

In 1979 Randall G. Michel, G. J. Baylin, A. S. Hall, I. H. Pipkin and W. R. Hudson of Duke University reported palatal tomography to be of benefit in diagnosis of occult hard palate defects. Although not advocating wide clinical use of this technique, they noted:

Nine of the 12 patients were found by tomography to have palatal defects that had not been detected either by cineradiography or by clinical investigation, including physical examination of the palate.
Defining SMCP

In 1970 George F. Crikelair, P. Striker and B. Cosman of the College of Physicians and Surgeons, Columbia University, New York, presented a provocative stand against limiting the diagnosis of submucous cleft palate to Calnan’s triad. They stated:

Actually, there is no such single grouping of findings that can be defined as a submucous cleft palate.

As recognized by the classical authors, from von Langenbeck through Dorrance, there is a variety of submucous defects in which a submucous zone (either large or small) is present together with (or rarely, without) an actual cleft—which, in turn (when present), may be large or small. The submucous area may be in the hard palate, the soft palate or both; the palatal bony defect may vary from near total absence to apparent normality (without even a notching of the posterior margin). This wide spectrum of anatomical appearances is borne out in our experience; the only constant feature of the “submucous cleft palate” is the presence of a submucous zone.

They presented their stand diagramatically in Plastic and Reconstructive Surgery, with the dotted area being the submucous
defect, the dashed line the posterior edge of the hard palate, and the dashed and dotted line the normal outline of the alveolar ridge or posterior edge of the hard palate or the posterior edge of the velum.

Crikelair's team, with a surgical experience of 20 significant submucous cleft palate cases, opposed the accepted dogma of excision of the submucous zone and palate pushback.

When the submucous area is large its excision may leave little tissue for palate closure of any kind—and predispose to breakdown and fistula formation. On the other hand, it is clear that significant submucous defects are not always associated with short soft palates and/or short hard palates. Consequently the insistence on a push-back procedure in all cases is hard to justify.

Our experience demonstrates that good speech results may be achieved without excision of the submucous section of the defect and/or without a push-back procedure. Where the palate does appear to be short, a primary pharyngeal flap may be used (without submucous zone excision). Where the submucous portion is smaller, narrower, and in the soft palate, and where the palate segments are ample, excision and a simple von Langenbeck closure can give good results. . . . It is thus possible to approach therapy in each instance of submucous defect freely.

In 1969, 1970 and 1974 John E. Hoopes and others of Johns Hopkins University confirmed by cineradiography the early finding of Dorrance that the anatomical defect in submucous cleft palate was the insertion of the levator palatini muscles too far forward to elevate the soft palate effectively. He defined the factors responsible for velopharyngeal incompetence in submucous cleft palate as (1) a short soft palate and (2) an anteriorly displaced levator insertion. The more anterior the levator insertion, the greater the velopharyngeal incompetence.

Asymptomatic SMCP

Another surgeon interested in submucous cleft palate is R. C. A. Weatherley-White of Denver, who seems to spend most of his free time in the air. Born in India into a third-generation Indian Medical Service family, he served as a paratrooper in the 82nd Airborne Division, was once United States National Inter-Collegiate Sky Diving Champion and is now learning to fly aerobatically. His first contact with plastic surgery was through Sir Archibald
McIndoe’s visit to the R.A.F. Hospital at Holton, and he later trained with Richard Stark in New York.

In 1972 Chris Weatherley-White, C. Sakura, L. Brenner, J. Stewart and J. Ott of the University of Colorado found nine submucous cleft palate cases in a study of 10,836 Colorado school children in the Denver area. This presented an incidence of 1:1,200, but only one child had mildly abnormal speech and it was corrected by therapy alone. In these and 52 other submucous cleft palate patients referred, the combination of a relatively short palate with lessened mobility and demonstrable easy fatigue with effort was noted. Speech proficiency was not related to the degree of muscular clefting. Only four patients had surgery, and this involved the complete excision of the diastasis (“zona pellucida”) combined with pharyngeal flaps in all, plus Veau-Wardill push-back in two. Hypernasality was corrected in three and improved in one.

Weatherley-White wrote in 1976:

In our epidemiological studies on submucous cleft palate, I am constantly reinforced in our initial premise by the fact that I see so many asymptomatic submucous cleft palates. My aphorism concerning this lesion would be to follow all children with submucous cleft palate very carefully with frequent routine speech evaluations. Surgery should be done if there are signs of velopharyngeal incompetence; this should obviously be done as soon as the diagnosis is made, to prevent neurological pathways becoming stratified and causing a persistence of the speech problem.

In 1973 Raymond Massengill, K. Pickrell and M. Robinson of Duke University reported on a comparison of 12 submucous cleft palate patients with a random group of 12 postoperative cleft palate patients. The groups were matched according to age and sex, and all had some type of pushback procedure with what was presumed to be adequate length—either a Veau, a Dorrance, a Dorrance with an island flap, a Wardill or a Wardill with an island flap. In their small series, the submucous cleft palate patients had a higher percentage of velopharyngeal incompetence than the controls. This was partially explained by the later diagnosis of the patients, after they presented speech problems, and resultant greater palatal height in the control than in the submucous cleft palate groups.
Methods of Treating SMCP

In 1970 John Hoopes with A. Dellon, J. Fabrikant and A. Soliman of Johns Hopkins University suggested:

The procedure of an island flap pushback alone has proved disappointing in the management of submucous cleft palate, for which reason the combined procedure [island flap and pharyngeal flap] is utilised. The difference in the type of closure obtained with an island flap pushback versus a pharyngeal flap is essentially the difference between active and passive closure, respectively.

They reasoned that, in addition to the increase in active closure achieved with the posterior displacement of the levator muscles by the island, extra passive aid was given by the tethering of the pharyngeal flap.

In 1974 N. Culf, J. Chong and L. Cramer of Temple University stated that one of the ideal candidates for the double sandwich island flaps was the submucous cleft palate patient and reported 10 cases so treated. They wrote:

In cases of submucous cleft with significant separation of the levator muscles, the muscle bundles are easily approximated through the transverse incision at the junction of the hard and soft palate.

F. L. F. Innes of Norwich, England, trained by Kilner and Peet and influenced by the work of Calnan, is convinced that early cleft palate closure is ideal and is concerned that submucous clefts escape detection. He wrote in 1976:

Most of the patients do not reach me until a year or two after they have gone to school. This condition is still too often diagnosed much too late with the result that the unfortunate child is greatly handicapped.

The educational and psychological problems of late diagnosis are by themselves bad enough but there are in addition physical problems. The soft palate elements in such patients are very poor and underdeveloped. The standard Kilner-Wardill operation is probably adequate for children with submucous clefts who are presented for operation at about the age of one year, but if there is any doubt about the result of this operation by itself, an island flap . . . can be easily introduced. For older patients, the Kilner-Wardill operation is not adequate. Something more is required because in such patients the pharynx will have become excessively large. The pharynx seems to grow too wide and too deep without the influence of proper palatal muscle action in the front of the palatopharyngeal isthmus.
In these cases Innes advocated the combination of a pushback procedure aided by an island flap and complemented with reduction of the pharynx by the Hynes pharyngoplasty.

In 1975 in the *Cleft Palate Journal* E. N. Kaplan of Stanford University noted that the classic submucous cleft palate with Calnan’s triad represents the obvious overt physical signs of an underlying anatomical abnormality—the insertion of the levator and other palate muscles onto the hard palate instead of forming a sling across the midline. He stated:

As a result of this muscle malposition, velar function may be abnormal and velopharyngeal incompetence may result. We now recognize that muscle malposition can occur in the absence of the triad of overt signs. This condition is designated “occult” submucous cleft palate.

We believe that isolated cleft of the secondary palate, submucous cleft palate, and occult submucous cleft palate are variations in expression of the same embryologic disorder. . . . However, we would exclude cleft palate associated with craniofacial syndromes . . . branchial arch syndromes . . . mandibular micrognathia . . . and cleft palate with cleft lip . . . because they are probably embryologically distinct conditions.

Kaplan reviewed 250 cases of velopharyngeal incompetence without cleft lip or cleft palate and identified 41 cases of classic submucous cleft and 23 cases of occult submucous cleft. Here are his diagnostic aids:

1. Facial features suggestive of occult or classic SMCP:
   a) maxillary hypoplasia—"dish face" (75%)
   b) lip contour deformity at vermilion border—"gull wing" (75%)
   c) drooping of oral commissure (25%)
   d) dynamic facial muscle abnormality (25%)
      paranasal bulge—horizontal
      lateral lip bulge—vertical
      hypoanimation—a "dull" face or expression
   e) external ear abnormality—flat arc of superior helix (10%)
   f) alveolar arch abnormalities (5%).
2. Cephalometric studies revealed that in 90% of patients, the hard palate length was less than average but within one standard deviation of normal; in 75% nasopharyngeal depth was greater than average and only 10% fell more than one
standard deviation away from normal, but in 90% the soft palate was short by one standard deviation and 75% were short by two standard deviations.

3. Cinefluorographic studies were recommended to confirm velopharyngeal incompetence and to help determine need for therapy or surgery.

Kaplan noted:
Ultimately, however, the definitive diagnosis is dependent upon the intra-operative exploration of the soft palate muscles.

He then elaborated:
1. A midline incision extends from the distal centimeter of the hard palate to the proximal centimeter of the soft palate.
2. The oral mucoperiosteum is lifted laterally with a periosteal elevator and the oral mucosa of the soft palate is dissected sharply with scissors. Extreme care must be taken to avoid cutting into the muscle or damaging the mucosa.

He admitted to great variation of levator muscle insertion but noted that 75 to 90 percent of the levator muscles inserted on the bone with some muscle meeting in the midline.

Kaplan outlined his surgical approach:

1) If the diagnosis of occult submucous cleft palate is not confirmed (i.e., muscle anatomy is normal), the following plan is generally followed:
   a) Patients with normal palate mobility—retropharyngeal implant.
   b) Patients with palate paresis—obturating pharyngeal flap.
2) If there is an occult submucous cleft . . . we have reconstructed the palate by levator muscle reconstruction [A], palate pushback, and high superiorly based pharyngeal flap inserted into the raw surface of the nasal side of the palate [B].

This is the method described in 1965 by Dibbell, Laub, Jobe and Chase, applied to occult submucous clefts by Kaplan with the addition of reconstruction of the levator muscle sling.

In 1975 Minami, Kaplan, Wu and Jobe of Stanford University reported finding that 44 percent of submucous cleft palate patients with velopharyngeal incompetence had decreased palatal mobility on lateral cineradiography. They also pointed to the tethering effect of the abnormal levator insertions into the posterior hard palate as the key defect in SMCP. As they wrote:

The levators contract isometrically against an immobile insertion; thus, they may appear to be paretic.

They also reported four patients with none of the classic findings of SMCP who, after palatal exploration, revealed in each case a very small bony notch, unmistakable abnormal levator palatini insertions into the posterior border of the hard palate and diminished palatal mobility.

Treatment: As pointed out by Weatherley-White, normal speech will develop without any treatment in about 90 percent of SMCP patients, making early treatment inadvisable. For cases that do come to surgery, the Stanford group advocates, as standard procedure, *pushback* to correct the short palate and release the abnormal levator attachments and *superiorly based pharyngeal flap* to line the raw area and hold the backward displacement with a partial obturation of the velopharyngeal gap. To this they have added *reconstruction of the levator sling*.

In 1976 Frank E. Abyholm of Oslo, Norway, reported 47 submucous cleft palate patients, operated on at the average age of 10.8 years during 1965 to 1974. Eleven had had tonsillectomy and/or adenoidectomy prior to diagnosis. He noted better results when the patient was operated on under 7 years of age and from his experience advocated von Langenbeck or pushback palate closure with levator muscle sling construction and a superiorly based pharyngeal flap.

Meanwhile, Porterfield had continued his interest in the palate
and submucous clefts. In 1976 he recalled the problems faced 20 years ago and felt encouraged by the improvements that have followed:

My venerable old Chief, Harold Trusler of Indianapolis, had a reputation for being a gruff, tough old fellow, but who beneath the surface, was a very gentle and kind man. He would look at a previously operated palate that demonstrated much scar and immobility, turn away and say to the gathered audience, "that surgeon just had a bad pair of hands." To me, this merely points out what has been accomplished in these years.

The Calnan Controversy

Eleven years after his first paper, Porterfield, with Mohler and Sandel in 1976, still held rigidly to Calnan's triad as requirements for a case to be admitted to the inner sanctum of "submucous cleft palate." In a direct attack:

We would take issue with the statements of Crikelair et al in which they described submucous defects in association with overt cleft palate deformities and designated that deformity also as a SMCP. We feel the strict criteria of Calnan are valid ones for delineating the submucous cleft palate problem.

Meanwhile, Porterfield became aware that a pushback at 16 to 18 months was not sufficient treatment of SMCP. He began backtracking with an "ink had hardly dried" revision, suggesting in 1976 that a primary pharyngeal flap, or a superiorly based pharyngeal flap combined with a von Langenbeck palatoplasty if the palate seemed short, would be a more efficacious procedure.

This, of course, excited a 1977 Letter to the Editor from Crikelair and Cosman to Porterfield in reference to submucous cleft palate diagnosis and treatment. Excerpts from the letter follow:

It is a simple fact that submucous defects can occur in the hard palate without any involvement of the soft palate. It has also been observed that extensive submucous defects in the hard and soft palate may coexist with clefts of the soft palate considerably larger than a mere bifid uvula. Such cases have been amply documented [Crikelair et al., Roux, Demarquay, Tréalat, and Veau]. What name could one give to these defects, if not "submucous cleft palate?"

The restrictive criteria of Calnan serve to perpetuate the view that submucous cleft palate is a wholly different entity from cleft palate, rather than one of its manifestations. This concept has led Calnan, Porterfield, and
others to the too severe stricture concerning the necessity for excision of the submucous portion of the defect, a view which Dr. Porterfield and his colleagues now agree is in error.

It would have been generous of Dr. Porterfield et al to have pointed this out—and to have indicated, as they now also show, good speech may be achieved by the simple addition of a pharyngeal flap to the submucous cleft palate, without any other manipulation.

Porterfield’s 1977 reply to the Crikelair-Cosman letter ended:

My principal reason for disagreeing with them . . . is, however, simply that of being a “purist.” I think that the original description of Calnan should be retained, that it should not be confused by extraneous modifications.

To throw another dimension into submucous cleft palate, M. Fára of Prague stated in 1977:

All our 105 patients with submucous cleft manifested medial cleft palate with vomer in the central line . . . The wider the cleft in the palatal plates, the greater the parting of the velar muscles and the substituting attachments of these muscles to the palatal plates are functionally less valuable. Every fourth patient with submucous cleft was afflicted with the syndrome of developmental shortening of the palate: special physiognomy with striking hypomimia and decreased intellect.

A SIMPLER APPROACH

Dennis Walker of Johannesburg, who devised a different approach to the various submucous cleft palate problems, remembered a visit to the theater at 149 Harley Street when Gillies, in a mischievous mood, called through to Sir Archibald McIndoe in the next room, to ask whether Walker might watch him work:

McIndoe said, “yes, of course,” and then the wicked old maestro engaged my attention so that I was forced to stay with him, until McIndoe looked at me sideways when I eventually went to watch him.

With a touch of Gillies’ flexibility, Walker designed his attack on what he considered the specific problems of the submucous cleft, leaving the uvula, when not bifid, intact.

CONGENITAL HARD PALATE HOLES

Defects affecting only the hard palate are among the rarest found in clefts. They appear as oval holes in the midline, not usually
extending the whole length of the palate plates. Their occurrence is usually thought to be connected with a submucous cleft. Evidently there are exceptions.

In 1966 J. B. Lynch, S. R. Lewis and T. G. Blocker of the University of Texas, Galveston, reported a case of a Caucasian male with a moderately wide cleft of the hard palate extending from the incisive foramen to the junction of the hard and soft palates and an unattached, underdeveloped vomer. The alveolus was intact and the soft palate normal with microscopic sections of its midline revealing muscle fibers extending to the midline, which indicated that the muscular portion of the soft palate was, in fact, normally developed and did not represent a submucous cleft.

This defect, they felt, was not explained by any modern concepts of embryology.

It is more common, however, for this hard palate defect to accompany a submucous cleft palate. Both Trélat and Veau suggested that the phenomenon was a prenatal rupture of a submucous cleft, either spontaneous or artificial, and Fára endorsed their stand, estimating the occurrence of the opening at the time when the intrauterine growth of the head was reaching completion. In 1954 Calnan presented one of these cases with a hard palate hole accompanying a submucous cleft palate.

In 1971 in *Plastic and Reconstructive Surgery* Miroslav Fára of Charles University, Prague, reported five cases of congenital defects in the hard palate associated with typical complete submucous clefts and, in addition, slightly underdeveloped maxillae and marked hypoplasia of the palate plates.

TREATMENT

One of the cases reported by Fára was treated by F. Burian in 1935 with a mucoperiosteal rotation flap and inferiorly based pharyngeal flap.

Fára himself used a more refined approach. Excision of the midline submucous cleft area revealed the following:
On the sides of the excision, numerous cross-sectioned muscle fibers are seen; toward the midline they become rare, with an oblique or longitudinal change in direction. In the midline, however, the muscle fibers are completely absent and one sees only dense connective tissue.

Fára emphasized the importance of proper retropositioning of the palate, after detaching the muscle insertions from the posterior margins of the hypoplastic palatal plates, and suturing the muscles in the midline with a primary pharyngofixation [using a superiorly based flap.]

**PATHOGENESIS OF SUBMUCOUS CLEFT**

Dynamic David Poswillo of the Royal College of Surgeons of England Research Establishment in Downe, Kent, in 1974 reported an intriguing study of exogenous factors in the etiology and pathogenesis of complete and submucous cleft palate. A series of pregnant mice were given phenytoin in pediatric suspension at the rate of 150 mg per kilogram by gastric intubation from day 12 to day 16 of pregnancy. Examination of 100 consecutive fetuses at day 18.5 revealed 16 with complete cleft palate, 15 with submucous cleft palate and 69 normal. Serial study of the mouse fetuses in which SMCP had been induced supported the hypothesis of interference with mesodermal differentiation. A centripetal gradient of differentiation in the palatal shelf was described, commencing at the nasal foramen and extending to the uvula. When this gradient was disturbed by teratogens, after fusion of the palate, either SMCP plus bifid uvula, or bifid uvula alone resulted, the anomaly being determined by the stage of onset in relation to the anteroposterior gradient risk.

Study of the animal defect helped identify the causal mechanism in man. The findings supported the proposal that the teratogenosensitive period of palatogenesis in man should be regarded as extending from early embryogenesis to about the twelfth week of development. Until that time, agents can act to interfere with the developing palatal plates and the velar mesoderm in such a way that SMCP and bifid uvula, microforms of cleft palate, could result.
OTHER CAUSES OF VELOPHARYNGEAL INCOMPETENCE

In 1933, in his remarkable book *The Operative Story of Cleft Palate*, George Dorrance of Philadelphia discussed congenital insufficiency of the palate and categorized six varieties:

1. Normal appearance but inability of velum to approximate the pharyngeal wall because of anteroposterior shortening of the hard palate and velum.
2. Velum normal but hard palate short.
3. Hard palate normal but velum short.
4. Hard palate normal but submucous cleft of the velum.
5. Velum normal in appearance but with submucous cleft extending into the hard palate.
6. Palate insufficiency after successful cleft closure with the velum too short to reach the posterior pharyngeal wall.

Dorrance noted that children with congenital shortening of the palate usually learn to speak later than normal children, or speak indistinctly. Speech deficiency improves with time but is often associated with compensatory mechanisms such as development of compressor naris muscles and hypertrophy of the faucial and pharyngeal tonsils. His dissertation on diagnosis by symptoms was impressive.

1. Rhinolalia aperta or open nasalizing where vowels take a nasal tone ("ah" becomes "an"), consonants become altered with exception of "M" and "N" and sigmatismus, or the inability to produce the letter sound "S."
2. Shortness of breath in speaking due to air loss through the nose.
3. Inability to whistle.
4. Inability to hiss.
5. Inability to blow out a candle flame.
6. Mouth breathing becomes a habit presenting a vacant expression.
7. Pronounced facial movements with such muscles as the nasal compressor and corrigitors to turn the patient into a "face-talker."
8. Diminished hearing due to improper ventilation of the middle ear.
10. Fast talk avoiding difficult words.
11. Intra-oral examination reveals velopharyngeal insufficiency due to overall shortness of the palate and possible weakness in the superior pharyngeal constrictors.
12. Intranasal examination reveals insufficient velopharyngeal closure.
13. Bifid uvula in some cases.

14. Palpation through normal mucosa reveals various examples of submucous cleft in the muscles of the soft palate and the bone of the hard palate.

15. Irregularity and crowding of teeth, congenital absence of maxillary incisor tooth or the association with cleft lip.

In reference to nasal escape Dorrance stated:

The most reliable test is to hold a piece of cotton in front of the anterior nares while the patient makes efforts to pronounce non-nasal letter sounds. The escaping air makes the cotton move when this mechanism is insufficient.

DIFFERENTIAL DIAGNOSIS

Dorrance warned that congenital insufficiency of the palate should not be confused with palsy of the velum, “stomatolalia” and speech defects due to loss of teeth or faulty lingual articulation. Palsy of the palate is recognizable by the absence of the palatal reflex, inability of the velum to move and its lack of response to faradic stimulation. Stomatolalia or rhinolalia clausa is a condition of speech in which the letter sounds lack their nasal resonance. Dorrance added that speech defects due to loss of teeth are correctable by dentures and, if due to faulty tongue habits, are benefited by methodical speech training. He recommended his “push-back” operation of the palate as the best treatment of congenital insufficiency.

In 1954, while still at Oxford University James Calnan outlined, in addition to submucous cleft palate, other causes of velopharyngeal insufficiency:

2. Cerebral agenesis of the supranuclear bulbar origin.
3. Paralysis of the palate (infectious or viral, which usually clears after recovery from the infection).
4. “Tonsillectomy palate” in which the surgeon has taken a portion of the soft palate along with the tonsils.
5. Functional rhinolalia where the patient “talks down the nose” for no apparent reason.
6. Rhinolalia following adenoidectomy.
RHINOLALIA AFTER T & A

Great interest has been shown in the condition of velopharyngeal incompetence following adenoidectomy.

In 1958 A. G. Gibb published his findings on a series of 19 patients seen by him in Scotland with permanent nasal escape following removal of tonsils and adenoids. He found that there had been 27,734 operations for removal of tonsils and adenoids in a population of 62,000 from 1950 to 1957. The incidence of permanent speech defect was 1 in every 1,459. Yet Calnan reviewed the Scottish series and indicated the probability that five were submucous cleft palate patients and four were mentally retarded with possible congenitally large pharynx. Gibb, he noted, felt that the soft palate was short and considered this factor the cause of nasality after adenoidectomy.

In 1971 James Calnan of the Royal Postgraduate Medical School, London, reported that between 1951 and 1968 he had a series of 19 patients with permanent nasal escape during speech following removal of tonsils and adenoids. All had had normal speech prior to the T & A and were above average intelligence. Radiological studies demonstrated a fully mobile soft palate with a gap between it and the posterior pharyngeal wall. When the gap was occluded by a cartilage implant behind the posterior wall of the pharynx, speech returned to normal. Cephalometric measurements suggested that the essential defect was a pharynx deeper than normal. He stated:

A good analogy would be a size 7 foot in a size 8 shoe: both are "normal" but of little use together.

Calnan acknowledged that the disproportion between palate and pharynx was probably not possible to diagnose before adenoidectomy.

In 1975 Roland Minami, Ernest Kaplan, George Wu and Richard Jobe of Stanford University reported on 23 patients with hypernasality following removal of adenoids and tonsils. In most cases, they noted, velopharyngeal incompetence after a T & A is transient and disappears in a few weeks after compensation for the missing adenoid prominence. A marginally adequate mechanism may not be able to cope and will "unmask" the presence of
a submucous cleft or other pathology. Surgical experience with the standard Stanford pushback with superiorly based pharyngeal flap achieved improvement of severe to moderate hypernasality to minimal with the best prognosis in patients with normal amplitude and quickness of palatal motion. Nine patients had no surgery and, out of six of these followed three years, two showed improvement.

Noting the extensive reports of good results in such cases with retropharyngeal augmentation, Minami and his colleagues admitted favoring this approach "with a velopharyngeal gap of 5 mm. or less." When there was preexisting hypernasality worsened by T & A, surgery, they felt, should be directed toward correction of the underlying cause.

PROPHYLAXIS

It is important that children with congenital palatal incompetence who have only minimal hypernasality not be subjected to a standard adenoidectomy. Subtelny and Koepp-Baker advised that when adenoidectomy was absolutely indicated because the adenoid tissue covered the orifices of the Eustachian tubes, a lateral band adenoidectomy could be done, leaving the bulk of adenoid tissue in the midportion of the pharynx undisturbed.

CONGENITAL LARGE PHARYNX

By 1971 James Calnan of London had added congenital large pharynx to his list of six groups besides submucous cleft palate which can result in velopharyngeal incompetence. He reported a personal series of 41 patients seen over an 18-year period presenting nasal escape with apparently normal palatopharyngeal mechanisms. Extensive clinical and cephalometric studies revealed the pharynx to be larger than normal, justifying the term congenital large pharynx.

Calnan found no improvement with the Wardill-Kilner V-Y procedure, lack of nasal resonance with the Hynes procedure, extrusion of Teflon implants and the best results with autogenous costal cartilage implanted in the retropharyngeal area above the
arch of the atlas. His overall result was 60 percent normal speech obtained after the various types of surgery.

In 1975 Minami, Kaplan, Wu and Jobe of Stanford University divided velopharyngeal incompetence without overt cleft palate into the "Big Four":

1. Acquired palatopharyngeal disproportion after removal of adenoids and tonsils.
2. Abnormal anatomy of levator palati muscles—submucous cleft palate.
3. Palatal paresis.
4. Other causes—mental retardation, congenitally short palate, congenitally large pharynx and possible "occult" SMCP.

In 1979 W. S. Hagstron, R. W. Parsons, S. J. F. Landa and M. C. Robson of the University of Chicago, reported two cases of familial velopharyngeal incompetence caused by myasthenia gravis. They suggested consideration of: "myasthenia gravis (electromyography or testing with edrophonium) when the cause of neuromuscular dysfunction cannot be definitely established."

**PALATAL PARESIS**

The discussion of the treatment of palatal paresis by Minami et al. is of special interest. They noted that surgery has included pharyngeal flaps, citing Randall, Bakes and Kennedy (1960), J. C. Hardy et al. (1961), and Crikelair, Kastein and Cosman (1970); unilateral pharyngeal flap limited to affected side in unilateral palatal paresis, suggested by Broadbent and Swinyard (1959); and temporalis muscle and fascial sling reported by Kiehn et al. (1965). The obvious objective in a paralyzed palate is the construction of an almost complete obturator. If this can be accomplished by Hogan’s wide, lined pharyngeal flap closing off the lateral ports to 3 mm., then that is the method of choice. Palatal lifts and obturating types of prosthesis have been used successfully and may be the treatment of choice, at least in patients with cerebral palsy, as noted by Gibbons and Bloomer (1958), Lang and Kipfmueller (1969), Gonzales and Aronson (1970) and Hardy et al. (1969).

In all types and degrees of palatal paralysis resulting in velopharyngeal incompetence, the pharyngeal flap, by reduction,
constriction and obturation of the velopharyngeal aperture, has earned an important place in the surgical treatment. Its contribution is great even to such rare conditions as congenital suprabulbar paresis described in 1950 by Worster-Drought, in which the motor outflow to the tongue, lips, palate, pharynx and larynx is affected. In the mildest form of this syndrome, the soft palate suffers most with a marked rhinolalia. In 1958 Wynn Williams of Nottingham, using the Rosenthal pharyngeal flap, reported good results on 49 percent of the patients.

At the 1973 International Congress on Cleft Palate in Copenhagen, C. H. Waar of the University Hospital Dijikzigt, Rotterdam, advocated surgical fixation of the uvula to the lower adenoid region for speech improvement in paralysis of the soft palate. The chance of improvement is far better if, during phonation, a constriction of the pharyngeal musculature is noted. Waar cited two successful cases, a 5-year-old girl with bilateral paralysis of the glossopharyngeal nerve but no other neurological symptoms, and a 30-year-old male with dysarthria, hemiplegia and open nasality as a result of a traffic accident. After long, unsuccessful speech therapy, a uvula fixation was followed shortly by a definite reduction in nasality.

In 1977 at the Third International Cleft Palate Congress in Toronto, Donnell F. Johns, Ph.D., and Kenneth E. Salyer of the University of Texas Southwestern Medical School, Dallas, determined the width of their obliterating superiorly based pharyngeal flap by observing and marking the most medial excursion of the lateral pharyngeal walls. Using this width flap, they were able to report 14 successes out of 15 cases of neurogenic velopharyngeal incompetence.

In 1975 alert Jack C. Fisher of the University Hospital, San Diego, and M. Edgerton of the University of Virginia Hospital, Charlottesville, reported the combined use of the levator retrodisplacement and pharyngeal flap for congenital palate insufficiency. They presented their argument:

The retrodisplacement principle has been combined with a pharyngeal flap in a manner which provides muscular union between the LVPM [levator veli palatini muscle] in the midline of the soft palate and the fibers of the superior constrictor in the posterior pharyngeal wall. Continuity of muscular tissue at the borders of each new lateral velopharyngeal portal thus provides
an anatomic configuration with the potential for functional sphincter action.

Acceptable indications for this procedure include non-cleft palate insufficiency, clefts of the soft palate with short levator insertions, and previously repaired clefts with persistent nasality.

They use this approach in primary palate surgery, combining it with an extensive pushback. Their outline of the procedure in the *Cleft Palate Journal* began with elevation of mucoperiosteal flaps, freeing of vascular bundles and division of the nasal floor in the midline. This was followed by division of levator muscle bundles from the hard palate insertion as well as from the mucoperiosteum and nasal floor in order to permit retrodisplacement. Then a superiorly based pharyngeal flap was turned into the nasal defect and the levator bundles joined in the midline at the base of the flap. After completion of the palate pushback, catheters were left in each portal and fixed to the columella.

Here are Fisher's remarks in 1978 in reference to the paper:

First of all, it was the first honest admission that levator retrodisplacement alone in children with non-cleft velopharyngeal incompetence isn't very good very often. Second, it suggests a theoretic means for establishing a dynamic sphincter around the newly formed velopharyngeal portals. As of today, that is still speculative and unproven. I'm not sure my convictions are still strong that one can produce a dynamic sphincter with inherent muscular function. I was reminded of this when I listened carefully to Otto Kriens in Toronto last year. Surely, he has applied the levator repositioning principle most avidly, but he feels it is of advantage only within the first few months of life. I wonder if we have any chance at all of redirecting the function of those muscles if we wait until the child is 8 or 9 or 13? Thus, Levator Retrodisplacement with Pharyngeal Flap asks more questions than it answers.

**PUTTING IT ALL IN PERSPECTIVE**

After 150 years, finally, at the 1977 Third International Congress on Cleft palate in Toronto, Samuel Pruzansky, with S. Peterson-Falzone, J. Laffer and P. Parris of the University of Illinois Center for Craniofacial Anomalies, imposed order on the chaos of the loosely grouped and ill-defined cases of hypernasality in the
absence of an overt cleft:

Hypernasality may be due to 1. disorder of the nervous system, 2. end organ defects, or 3. a combination of both.

All these cases of hypernasality were grouped under the heading of “Congenital Velopharyngeal Incompetence” (CPI) because the causative factors are present at birth. The incompetence (hypernasality) cases were divided into two groups, CPI(1) and CPI(2). In CPI(1), one or more of the triad of associated structural defects are present in a frequency of: bifid uvula, 85 percent; dehiscence of velar muscles, 65 percent; submucous cleft of the hard palate, 73 percent. Pruzansky noted that these associated defects are not causes of hypernasality, and one, two, or all three can be present without hypernasality. In CPI(2), no visible or palpable stigmata are present.

Radiographic examination of both types revealed one or more of the following: short or thin velum, platybasia, craniovertebral anomalies contributing to a deep pharynx, paucity of adenoid and early involution of adenoid.

CPI referral over the past 25 years has shown an increase in absolute number and in proportion to overt clefts, with an incidence of 49 percent CPI(1) and 40 percent CPI(2).

A study of 20 families of each group revealed the incidence of inheritance. CPI(1) showed a family history in 16.8 percent and CPI(2) in 22.2 percent, with an overlapping. Family history of clefts was seen in CPI(1) in 18 percent and in CPI(2) in 9.1 percent. It not only runs in families; it runs in syndromes!

As noted by S. Peterson-Falzone, S. Pruzansky, J. Laffer and P. Parris:

Both [CPI] types may occur in conjunction with a number of known craniofacial malformation syndromes, including mandibulofacial dysostosis, Klippel-Feil, von Recklinghausen, hemifacial microsomia, familial craniovertebral malformations, and others. Patients with Apert syndrome and Crouzon disease frequently exhibit the stigmata associated with CPI type 1 but do not show hypernasality due to decreased depth of the pharynx and abnormal size of the soft palate. In the presence of an overwhelming constellation of malformations, the hypernasality may be overlooked.
44. Timing Palate Surgery

The optimum timing of palate surgery has been, and still is, a much debated subject. Before the advent of anesthesia, palate closure was postponed until adulthood. Today, with endotracheal anesthesia, palate closure is possible at any age. It is logical that the sooner the palate cleft is closed the easier it will be for the patient to develop normal speech patterns, avoiding bad habits gained during compensation for an inadequate velopharyngeal sphincter. Thus the most popular time for closure of a palate cleft has been set at about 18 months of age, or the time when speech begins to develop.

All reports on the effect of the age at the time of palate closure indicate that the earlier the operation, the more normal the speech. Holdsworth reported that his youngest group, 6 to 9 months, had 77 percent apparently normal speech as opposed to the next age, 10 to 12 months, with 54 percent normal speech. Peet’s earliest group, 12 to 15 months and 170 V-Y “pushbacks,” showed 82 percent without nasal escape as compared to the next age, 16 to 30 months, with 77 percent. Axhausen found that patients with palates closed at 3 years had 80 percent normal speech, while those with palates closed at 4 to 6 years had only 71 percent. Lindsay found 70 percent acceptable speech when the palate was closed before 3 years and only 60 percent after 3 years. Jolley also found that the cutoff time for good speech was before 3 years. Calnan reported normal speech in 75 percent when operation took place between 1 and 2 years of age but only 40 percent at 4 years.

In 1964 Michael Lewin of New York published the answers to a questionnaire sent to all American and Canadian plastic sur-
geons in 1962. Of the 284 surgeons responding, 80.6 percent close the palate cleft between 1 and 2 years of age, with 18 months being the age of choice; 11.9 percent delay operation until the patient is between 2 and 4 years old. Only 15 surgeons operate on the palate before 12 months of age.

In 1972 S. O’Riain and B. N. Hammond of Odstock Hospital, England, noted that the majority of British surgeons, Battle (1954) and Braithwaite (1966) included, advocate operation at 1 year old or before the age of 18 months.

In 1976 Innes stated:

I believe, with Kilner, that the ideal time for the primary repair of all types of cleft palate is as early as possible... In almost all cases conditions are right for successful surgery at the age of one year.

**E A R L Y F O R S P E E C H**

Most speech pathologists favor early cleft palate closure because they are convinced that the speech results will be better with less effort. By 1964 Madame Borel-Maisonny had been P. Petit’s speech analyst long enough to follow 100 cleft cases and report the percentage of patients who recovered “normal” function of the soft palate during phonation—60 cases of 100 = 60 percent. Then she presented her statistics to probe the necessity of performing cleft palate operation before the age of 2 with the purpose of obtaining normal speech. In her study, she found that speech was normal in 63 patients, or 66 percent, operated on before 2 years of age but in only 37, or 33.4 percent, operated on after age 2.

Richard Cole, once speech therapist of the Lancaster Cleft Palate Clinic and chairman of the 1969 Symposium on the Early Treatment of Cleft Lip and Palate, and now at the University of Detroit Dental School, was quite definite about his feelings in reference to early palate closure and speech:

The fact that seems rather clear is that articulatory proficiency is related to the age at which palatal adequacy is established, but that there is a very definitely greater likelihood of encountering what we refer to as “cleft palate
speech” including glottal stops, pharyngeal fricatives, the later palatal adequacy is established. Integrity need not necessarily be by surgery as prosthetic separation may serve the purpose.

I think that most speech therapists would agree that glottal stops and pharyngeal fricatives are the most difficult sound substitutions to alter in the speech of cleft palate persons, and we know that the older the patient when he begins speech therapy, the less chance we have of completely eliminating this habit.

In 1974 D. Evans and C. Renfrew of Churchill Hospital, Oxford University, made a speech assessment of 229 cleft palate patients treated by Eric Peet using a Wardill-Kilner V-Y palatoplasty. It is interesting that their study showed a slight advantage conferred by operation within the first eight months of life, and strong theoretical arguments concerning early speech development and the effect of maternal separation after this age were presented in support of early operation.

Muriel Morley of Newcastle, speech pathologist for Wardill and later Braithwaite, recalled in 1977:

Regular observation of the developing speech from preoperative times until normal speech was established indicated that the majority of these children, submitted to surgery before three years of age, eventually developed normal speech without any specialised assistance.

Hughlett Morris of the University of Iowa stated in 1977:

We’re caught between the fear, set off by Graber in the 1950s, that early surgery leads to midfacial growth deformities and the suspicion labeled by Morley, also in the 1950s, that late surgery leads to a higher incidence of velopharyngeal dysfunction and patterns of misarticulation than otherwise expected. There are more data to support the former theory than the latter though in neither case is the picture entirely clear. Naturally, as a speech pathologist, I urge that early palatal surgery be seriously considered.

Kenneth R. Bzoch of the University of Florida, of Czechoslovakian descent and a co-editor of the extensive 1971 Cleft Lip and Palate, wrote in 1977:

I noticed most authority figures in Speech Pathology were either stutterers or had aphasia or some other claim to the Communicative Disorders field and all I had was a cleft palate in utero (before fusion) so perhaps that’s why I focused on this field.
After over a quarter of a century of experience the state-of-the-art in cleft palate research has progressed to the point where a challenging clinical team goal can be set. The goal of achieving speech, language and hearing function indistinguishable from that of their peers by three years of age for cleft palate infants has three critical steps too often missing in treatment programs today. In order of priority these appear to be: (1) early complete reconstructive surgery of both the hard and soft palate clefts between 12 and 18 months of age, (2) establishment of a regular early effective home speech and language stimulation program in years 1 and 2, and (3) early critical evaluation of the efficacy of primary surgical closure followed directly by secondary reconstructive surgery before 3 years of age when velopharyngeal insufficiency is indicated by clinical and diagnostic therapy techniques.

On the Efficacy of Early Complete Palate Closure. My experience clearly indicates the achievement of early functional palatal reconstruction does make a marked difference in the life of children with congenital cleft palates. Research to date is inconclusive mainly because the timing of primary closure rather than the date of achievement of velopharyngeal sufficiency to support speech has been used in the past studies addressing this question. Empirically it appears that the abnormal speech stigmata requiring later prolonged speech therapy are usually avoided when functional palatal reconstruction is accomplished before 18 months of age. When closure is routinely postponed for any reason or when primary closure is not successful in achieving velopharyngeal adequacy, compensatory articulation, breathing, and phonation habits almost regularly emerge between two and four years of age. This is because the pneumatic requirements of speech physiology do require a complete and rapid coupling and uncoupling of the velopharyngeal mechanism. The use of expressive oral language for obtaining wants and needs is regularly evidenced in all infants from years one to three. The adequacy or inadequacy of primary closure can be determined from clinical tests during diagnostic therapy for any child between one and three.

LATER FOR MAXILLARY GROWTH

In 1954 bone growth expert Wilton Krogman, while at the University of Pennsylvania, noted:

The palate grows relatively little after the age of about six years . . . [thus], an optimum time for surgical procedure which would be, both in theory and in practice, in accordance with growth dimension and growth potential, is somewhere between four and six years, with the earlier age acceptable in the great majority of cases. However, if the growth tempo in the individual child be such that there is evidence of advanced growth . . . it is possible that an earlier chronological age (as early as 2 to 3 years) may be permissible.
Bill Grabb called my attention to the 1968 Mosher Award winning work of Leslie Bernstein on the effect of timing of cleft palate operations on subsequent growth of the maxilla, published in *Laryngoscope*. I wrote Bernstein at the University of California, Sacramento, for recent information and was rewarded with a reprint and his permission to use any part for publication. The accompanying letter ended with

I am sure that your comments will be as fair and gracious as before.

Only those familiar with Chapter 33-1/3 in Volume I will appreciate the scalpel edge of this line, and I would take my hat off to him for it, if I had one.

Bernstein, with both dental and medical degrees, while in the Otolaryngology Department of the University of Iowa, made a study of 325 subjects with surgically corrected maxillofacial clefts and 49 without surgery of the palate defect. A von Langenbeck soft tissue closure had been done in 278 while 32 had a vomer flap several months prior to soft tissue closure. In 222 subjects the preoperative occlusion of the posterior teeth had been recorded in dental casts. All retained the preoperative occlusal relationships of the posterior teeth when examined postoperatively. Under the premise that "surgical assault on the palate interferes with its lateral growth," he emphasized

the need to delay surgery on the cleft palate until the deciduous molars are in occlusion. It also serves as a very favorable argument in support of instituting pre-operative orthodontic expansion of the palate in those patients who have already developed a cross-bite malocclusion, because after surgery the cross-bite usually becomes worse.

The main thrust of his paper was shown with two diagrams of the coronal section through the palate and mandible to show cusp relationships in the normal and in bilateral crossbite. Bernstein stated:

The mandibular buccal cusps, articulating on the inside of the maxillary buccal cusps, exert a wedging effect which prevents medial contraction after cleft palate repair. This effect is cancelled out in cross-bite cases.
He concluded:

The results of this study indicate that growth and development of the maxilla, and the appearance of the mid-third of the face, are materially altered if the palatal operation is performed before all of the deciduous molars are in proper occlusion—namely, before the age of 24–30 months. . . . It is concluded that the optimal time for cleft palate repair is between 30 and 36 months of age.

In 1977, in Toronto, N. Robertson and A. Jolyes of the Welsh National School of Medicine, Cardiff, presented a seven-year follow-up on 40 newborn infants with unilateral complete clefts of the lip and palate. They had been divided into two groups handled skillfully and identically, except in group 1 the hard palate was closed at 12 months while in group 2 the hard palate was closed at 4½ years. Serial records had been kept from birth onward, and no real differences in maxillary growth had been noted at 3 and 5 years of age. At 7 years there was still no marked difference, but the delayed group showed slightly better maxillary development, especially in the upper arch by cephalometric measurements, slight disadvantage in speech and no difference in ear problems. Robertson and Jolyes concluded that the type and degree of the original cleft condition was more important!

The orthodontists facing dental and maxillary deformities following early traumatic surgery have been effective in pointing out the direct relationship between the time and type of surgery and the severity of the deformities. They have promoted both reduction of traumatic surgery and delay of surgery. At present there is some concern about the effect of elevation of mucoperiosteal flaps and maxillary growth retardation. Early premaxillary setbacks have been discouraged. Yet both of these surgical procedures, at the right time, are acceptable. As most maxillary growth has been completed by 3 to 5 years, this is the optimum time if extensive elevation of mucoperiosteum is required.

Some surgeons, sympathizing with the ideal early palate closure for the best speech results, follow early surgery with expansion plates and other devices to maintain arch alignment against the postoperative scar contracture. This is not a luxury I enjoy.
TIMING AND TYPE OF SURGERY

In 1973 Wolfgang Koberg of Düsseldorf reported on electronically analyzed data on 1,033 cleft patients in Rehrmann's clinic. For the previous five years, speech had been evaluated by a speech therapist and maxillary growth investigated by the "Dysgnathia Index." Koberg summarized:

A direct linear relationship is existent between the age of operation and speech result. . . . The measure of iatrogenic disturbance in maxillary growth depends on the technique applied in palatoplasty. . . . Without any vital damage to maxillary growth, a relatively early but "atraumatic" palatoplasty at the age of 2-3 years can be achieved.

He concluded with suggestions for type and timing of surgery:

1. The isolated median incomplete or complete cleft palate should be closed in one sitting after the second year of life, using the pediculated [Veau] flap technique. Prognosis for normal colloquial language rates 65-70%.

2. The uni- or bilateral total cleft palate cases, we . . . advocate closure in 2 sittings: at the age of 6 months, primary closure of anterior part of cleft palate according to Pichler, with simultaneous closure of cleft lip and alveolus. And at the age of 2 years, the plastic closure of residual cleft using the stalked or pediculated flap technique [Veau]. Where a primary Pichler-plasty is not usable, Andrä (1966) still thinks that Schweckendiek's procedure should be attempted at the age of 12 months. The prognosis for acquiring a flawless colloquial language verges on 70% for unilateral complete clefts, and about 65% for bilateral cases.

3. Isolated clefts of the velum should be operated at two years of age, using the pedicle flap technique. To elongate the nasal mucosa, incisions [Z] should be made as suggested by Schuchardi (1966). This operation should be performed in spite of the expected unfavourable anatomical results. A favourable prognosis for very or fairly good articulation verges on 85%.

4. Submucous cleft palate should, without exception, be repaired with the bridge flap technique [von Langenbeck or Axhausen]. With nearly 90% incontestable functional speech result, these clefts have the most favourable prognosis.

EVEN EARLIER SURGERY

There is a new push on for very early palate surgery, including mucoperiosteal dissections.
In 1977, at the American Cleft Palate Educational Foundation Symposium on the Refinements in Cleft Lip and Palate Surgery held at Northwestern University, Ernest Kaplan of Stanford University made a strong argument for early total closure of the palate cleft. He set 4 to 6 months as the optimum time for palate closure to avoid bad speech habits, stating that speech results are better if the palate is closed at six months.

He cited the surgeons who have spoken out for earlier palate surgery and its linear relation to better speech results.

Kaplan further backed his argument for very early total palate surgery by his study of Central American Indians. As found by others, he had noted normal facial growth in the adult unoperated cleft case. Where the lip cleft had been closed surgically but the palate left unoperated, he found maxillary retraction. In two specific examples in which the palate had been closed but the lip left open, there was normal maxillary growth.

Kaplan also observed that clefts of the secondary palate, including submucous clefts (not including Pierre Robin and Treacher Collins syndromes), often show maxillary retraction. He suggested that early surgery of the palate in these cases should not be blamed except for possible slight crossbite deformities.

The palate operation he proposed was the standard V-Y Wardill-Kilner palatoplasty, vomer flap, freeing, uniting into a loop and retroposing the levator muscle fibers, and, in about 50 percent of cases, dividing the nasal mucosa from the hard palate edge and sliding into this defect a buccal mucosal flap.

At the same meeting, Desmond Kernahan, who has migrated from Oxford to Liverpool to Winnipeg to Chicago’s Children’s Memorial Hospital, also rose to the rostrum to champion early palate closure.

LOGICAL TIMING

Franz Härle of the University of Freiburg escapes in the summer to the near-deserted fishing village of Pelion in the Aegean Sea to hunt with the fishermen. Yet the majority of his energy is spent in orthodontic surgery, rat research on osteoplasty effects on
mid-face growth and the logical design of treatment timing of palate clefts. It is his conception that with each period of independence in the developing child there comes a greater effort to express himself, and thus orthodontia and surgery should be coordinated in time to facilitate these spurts of vocal effort. As he wrote in 1977:

In 1967 I formed a team with pediatricians, phonodiologists, otorhinologists and psychologists to care for about 1000 cleft children. Our main concern was to work out the most appropriate time for the treatment of the cleft child, taking into consideration the psyche, the speech development and the facial growth. The result of this study is described in German as "Freiburger Pfeffermühle" or "pepper-mill of Freiburg." The pepper-mill symbolises the phases of speech differentiation and undifferentiation. Operations in the soft palate and pharynx are only valuable when done in the phase of speech ind differentiation, so that the children can make use of the new anatomical situation when entering the next phase of speech differentiation. At the age of 20 years, and after complete dental rehabilitation, normal speech, satisfactory aesthetics and corrected occlusion, the cleft patient leaves our regular control.

FREIBURG'S PEPPER-GRINDER
PHASE-SPECIFIC DEVELOPMENT
OF THE CLEFT-CHILD

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GENERAL PERSONAL TIMING

In Miami at present I have no presurgical orthopedic aid available and thus have been forced into specialized staged surgical action.

_Cleft of the velum_

At 6 to 9 months retropositioning of the levator muscle into a sling and closure of the soft palate cleft in three layers are done. If the velum is short with good mobility, at 5 years a pushback with an island flap is used. If it is severely short, both an island and a posterior pharyngeal flap will be used in the pushback.

_Submucous cleft_

At 6 to 9 months, excision of the cleft area and retropositioning of the levator muscle with construction of a sling is followed by three-layer closure. If at 3 to 5 years there is velopharyngeal incompetence with good mobility but shortness, a pushback is used with a bipedicle island flap to the nasal defect. If the mobility is poor, a wide pharyngeal flap will be preferred.

_Severe horseshoe cleft of the secondary palate_

At 6 to 9 months, the soft palate is closed as much as possible. If molding and growth reduce the hard palate cleft enough, a modified von Langenbeck operation may close the hard palate at 18 months to 2 years. If the defect is still too large, there are two possibilities. The defect can be filled with an obturator or covered with a plate until 4 to 5 years, when an island flap and a pharyngeal flap can be used to aid pushback and closure. Another possibility at 18 months is to fill the nasal side of the cleft with a superiorly based pharyngeal flap and then close the oral side with the aid of von Langenbeck flaps.

_Complete unilateral cleft_

At 3 weeks of age, ear tubes are inserted, a lip adhesion is constructed and the soft palate is closed as much as possible. It is a temptation to turn a vomer flap at this time to close the anterior cleft but this is usually avoided. At 6 to 8 months, the definitive rotation-advancement lip closure is achieved. At 18
months, the vomer flap and a modified von Langenbeck (minimal incisions and undermining) can be used to close the hard palate defect. If the hard palate defect is too large, requiring extensive surgery, then a plate or obturator is utilized until the age of 3 to 5 years, when more radical surgery can be tolerated. Depending on the shortness of the palate and the amount of soft palate tissue, a pushback with an island flap and/or a pharyngeal flap will be employed.

**Complete bilateral cleft**

Rubber band traction to a headcap is started against the projecting premaxilla as soon after birth as possible. When the premaxilla is back enough for lip closure and the infant is ready physically for surgery (1 to 2 months), ear tubes are inserted, the soft palate is closed as much as possible and the lip is closed in one stage, bringing the lateral muscles together and banking the fork.

Closure of the lip and soft palate will help mold the premaxilla, and with growth the size of the hard palate cleft should be reduced. At 18 months to 2 years, if the hard palate cleft is reasonable, a modified von Langenbeck will succeed; and if the premaxilla is in good position, the alveolar clefts can be closed. In the event of velopharyngeal incompetence, a pharyngeal flap is first choice at 5 years since in bilateral clefts the amount of mucoperiosteum is limited, reducing the donor area for an island flap.

**Logic of Variation**

In Miami the basis of the general plan is first that the sooner the soft palate is approximated the sooner coordination begins between the velum and the pharyngeal musculature. Early adhesion or closure of the lip cleft molds the premaxilla and maxilla into alignment. This action, with the aid of growth, will decrease the hard palate defect, making possible a modified and less radical closure of the hard palate at optimum speech age. There is then a good chance that 75 percent of the patients will develop speech within normal limits without further surgery. The amount of
subsequent maxillary deformities is consequently reduced. At 5 years, when the major portion of the maxillary growth has been completed, more extensive and imaginative surgery is justified to correct velopharyngeal incompetence in the other 25 percent, so that by school age all should be well.

P. S.

While we are racing toward earlier surgery, it is well to ponder that there is an occasional patient who has had no closure of his palate cleft but has adjusted his pharyngeal musculature, tongue and palatal halves so that he can speak within normal limits. A 24-year-old black woman with an unoperated cleft of the soft palate and perfectly normal speech was seen when she brought her daughter with a cleft of the secondary palate into clinic. Timing of the surgery (in fact, surgery itself) was not important in this individual, but her child’s cleft will be closed as soon as it is physically feasible—I suppose...

The patients with palate clefts who can adapt without surgery are fascinating when you consider the problems operated palates experience. Then, to add further to the surgeon’s ego deflation, a discussion during the 1969 Chicago Cleft Palate Symposium is recalled, when Jan Dreyer of the University of the Witwatersrand, Johannesburg, announced:

Our cleft palate dogs are able to bring the two halves of the soft palate together after only two months and without treatment at all. Also they are able to lap food and they have no nasal bark.

Richard Cole of Lancaster countered:

In other words, they don’t say “Mark, Mark?”

Dreyer elaborated:

If these dogs get excited they do have a nasal bark but if not excited, they are able to control and approximate the two edges of their soft palates.
IN developing countries of the world, expediency in surgery, as in other aspects of life, must often take precedence over the ideal. When patients are forced to travel great distances to be treated by a plastic surgeon at all, as much as possible must be done for them at the one, and probably only, time. Seldom will they have a chance to return. If the lip cleft is closed, there will be less motivation to return as the palate cleft is not so easily visible. In these circumstances the surgeon is under pressure to try to close both the lip and the palate cleft in one operation. In the light of modern knowledge it may not be ideal for maxillary growth in the young child to carry out traumatic mucoperiosteal elevating procedures, but logic dictates that it is better to do "all" and take the chance of some secondary deformity than to settle for none or only part, thus retaining a portion of the residual cleft forever.

Of course, except for the time required, it is easier to do "all in one." Closure of the alveolar and hard palate cleft is greatly facilitated by the exposure afforded by the open lip. For many years, and even today in many clinics in England, the alveolus and anterior hard palate were and are closed at the time of lip closure. The crossbites created are being studied and treated by orthodontists.

FARINA

Brazil is a vast country of contrasts encompassing such extremes as the tropical jungles of the Amazon infested with the deadly
piranha to the great industrial city of São Paulo with skyscrapers and innovative plastic surgeons like Roberto Farina. Since much of Brazil is undeveloped, many clefts must travel great distances for treatment; hence the motivation for a one-stage closure of the entire cleft. Farina, who had used the two-stage Veau successfully, wrote in 1958:

Today, we have come to think that one can easily do everything at once in certain cases.

He set the age at 1 year or older and reported 23 such cases with the average operating time of two hours and normal recuperation. His one-stage cheilognathouranostaphyoplasty included a Veau-type closure of the alveolus and hard palate extended to close the soft palate followed by a LeMesurier lip closure. He cited the advantages:

1. This is hardly any risk to the patient.
2. One avoids two operations and thus two anesthetics—a doubled risk.
3. One no longer has the difficulties which one had at the junction of the hard and soft palate in palatoplasties done in two stages as recommended by Veau.
4. The closure at the level of the alveolar arch becomes easier with a perfect reconstitution of the nostril floor, without having to fear the appearance of bucco-nasal or vestibular fistulae.
5. It is more economical for the patient.
6. The results, in general, are "marvelous" from an anatomical and morphological point of view.

The 1971 Melbourne International Congress was the site for simultaneous reporting by Manchester, Kaplan and Davies of simultaneous lip and palate closure in one operation.

**MANCHESTER**

William Manchester of Auckland, New Zealand, is rather proud of his extensive closure of the alveolar and hard palate cleft along with his lip closure. This radical action is with the aid of presurgical orthodontics by Peat in the form of an expanding plate to spread the maxillae and simple elastic traction to restrain the premaxilla, so that by 5 months the segments are prepared. As he
wrote in the 1971 *Transactions* of the Melbourne International Congress:

Everything is now ready for the first stage of the programme which aims to repair not only the lip on both sides but the whole length of the hard palate as well. Thus, when the second stage is reached at the age of nine months, only a cleft in the soft palate remains.

Manchester's second stage involves a palatal pushback using the Cronin posterior advancement of the nasal mucoperiosteum and a V-Y retropositioning of the oral mucoperiosteum. This totally denudes the hard palate at 9 months of age; which outcome should give some interesting data after 20 years.

Manchester also has a third stage for rhinoplasty and columella lengthening at 15 years. Thus the number of surgeries is not remarkably reduced.

**KAPLAN**

Isaac Kaplan, born in the Orange Free State, served as an intelligence officer in the South African division of the 8th Army during World War II and received his degree after the war at the University of the Witwatersrand Medical School in Johannesburg. Trained by Sir Harold Gillies in England, he established a plastic surgery department in Beilinson Hospital, University of Tel Aviv, Israel, where, during the Yom Kippur War, he turned over an entire floor for care of the wounded. Kaplan, also a pioneer in the development and use of a continuous-wave carbon dioxide laser knife, in 1974 with Dresner, Gorodischer and Radin, recalled his work at Barsky's unit in Vietnam:

In 1 year (1968–1969) over 400 untreated cases of cleft lip and palate were seen at the Children’s Medical Relief International Plastic Surgery Unit in Saigon. Their ages ranged from infancy well into adulthood. Because of the workload and the difficulties of multiple-staged operations, simultaneous repair of the lip and palate was carried out on some of the older patients (Kaplan and Wesser, 1971). The operation was found to be so technically feasible that it soon became routine for infants too.

An experiment was set up in Israel between 1970 and 1972 in which 13 cleft infants had the combined lip and palate closure at
3 months and a control group of 13 cleft infants had the lip closed at 3 months and the palate at between 10 and 12 months of age. The lip was closed by the LeMesurier or Millard operation, the palate by the von Langenbeck with no attempt at closure of the alveolus, primary bone grafting or premaxillary setback. Naturally, the psychological effect of early complete cleft closure lessened family tensions at this stage. No maxillary growth retardation had been noted after two to four years and none would be expected to be noticeable at that time. The incidence of ear infections was much less in the experimental one-stage group. Study of speech development was of interest:

Commencement of “babbling” in the experimental group was comparable with normal children whereas in the control group it was delayed.

Uttering of first sounds such as nasal sounds and sibilants commenced at the time expected for normal children and was delayed in the control group. “One-word response” appeared in all these cases at the time expected for normal children, whereas in the control group this was delayed.

Two- to three-word response was delayed as compared to normal children but was manifest earlier than in the control group.

The initial nasal sounds on which intelligibility of phonation depends were judged to be adequate in 40 per cent whereas the remaining 60 per cent were comparable with the control group.

Word intelligibility was adequate in 50 per cent of the cases whereas the remaining 50 per cent were comparable with the control group.

Three of these children have now reached the age of fluent speech and speak normally with regard to length and sequence of the sentences although nasality is variable.
In 1977 Kaplan, enclosing these photographs, wrote:

We are at the moment preparing an article which will confirm our previous observations that the development of the maxilla in these cases of simultaneous repair of lip and palate is not significantly affected, provided the classical Langenbeck procedure is performed on the palate. The speech in these cases is highly satisfactory in a vast majority and our results compare very favorably with those of others.

DAVIES' TRUE ALL-IN-ONE CLOSURE OF THE CLEFT

David Davies of Capetown, South Africa, said at the International Congress in Melbourne, Australia, in 1971:

Our problem, which I am sure is common to all developing countries, is the difficulty of insuring adequate parental care and nutrition of these children until they are ready for operation. Farina approached this problem initially in adults by suggesting a one-stage repair. I was told many years ago that the late Eric Peet from Oxford repaired adult bilateral clefts in one stage while holidaying in India. However, most of these repairs were simple closures with no pushback and a high percentage of resultant fistulae. Unless one can produce a comparable or better result than a multistage procedure the operation should not be done. We started this operation at first tentatively in 1964, but the procedure has now become routine. . . . The lip is repaired with a Z-plasty, the alveolar defect grafted, and an extensive pushback done with the use of a Millard island flap. After the operation parental acceptance of the child is good and no further adjustments are necessary until the child is five or six years of age. . . .

A good speech result is the most important aim of the cleft palate repair. For this reason, the entire palate is closed before the child starts making any noises so that auditory feedback can be normal from the beginning; otherwise, it will result in habit patterns which are difficult to break. This is particularly important in the less intelligent patient. It has often been noted on cineradiography that an intelligent child will be able to use the pharyngeal muscles for a slightly short palate and still have good speech results.

In a series of 85 complete clefts of the lip and palate closed in one stage at 3½ months, with more than 60 percent of the children black, Davies reported 22 out of 27 at normal or near normal resonance (82 percent). His impression is that the longer, more mobile palate resulting from the island flap is giving much
better speech results, but would like to wait until he has 50
cchildren over 6 years of age before making a final comparison
with other series.

He does not agree with the orthodontists’ objections to an
island flap on the ground that it leaves a large raw area and the
resultant scarring causes collapse. The raw area epithelializes in
two to three weeks. No decrease in vault space has been noted in
any of the cases. Davies feels that in the one-stage closure there is
less surgical insult than in the multiple-staged procedure since
the operation is easier. This claim is borne out by the fact that he
had only two fistulae in 85 cases, one of which closed spontane-
ously.

In 1972, in a paper prepared for the Journal of the South African
Speech and Hearing Association, D. Davies, D. M. Whitting, B. H.
Miller, B. J. Cremin and D. Morrison gave an extensive report on
95 cases of one-stage closure. They discussed all aspects, but the
one of greatest concern was orthodontic assessment.

Results show that 47% of these patients have a Class III relationship of the
incisor teeth, i.e., the lower incisors occluding in front of the upper. The
remaining 53% have a Class I (or normal) occlusion. The maxillary minor
segment showed varying degrees of collapse in 66.7% of cases. This was
assessed by relating the teeth on the minor segment to the opposing man-
dibular teeth and noting the amount of collapse towards the midline.

Although the percentage of cases showing Class III incisor relationship
and collapse of the minor segment may appear to be high, these figures
compare quite favorably with those of other published series. Also, in many
of these cases, simple orthodontic treatment is all that will be required to
bring about correction.

In reference to speech assessment the senior speech therapist of
this group, D. M. Whitting, wrote in 1972:

95% of the children did not have normal speech. They had normal or near
normal nasal resonance. 60% had normal or near normal articulation. I think
we will have to wait till we have assessments of 50 children over the age of
6 years before we can quote figures suitable for comparison with other series.
Articulatory development is not stabilized in the normal child before 6–8
years.
In 1973 H. Wolfgang Løsken, trained by David Davies in Capetown and as a Maytag Fellow in Miami, wrote after one year of practice in Pietermaritzburg, South Africa:

The most exciting repair of all was when I did my first all-in-one cleft repair on a five months old complete cleft of the lip and palate, with a gap in the alveolus of 1.7 cm.

Løsken's next letter was written in 1974, and an excerpt from it is of interest:

I have now done three complete repairs of the lip and palate together with no fistulae. At our recent Congress in Johannesburg, Davies presented the results of his 110 complete one-stage repairs. He was certainly tremendously honest in his presentation and very critical of his own work and results. He is certainly a tremendous example to us younger surgeons who tend to be over-enthusiastic and possibly not sufficiently critical of our own work and results.

I got the impression from David that he felt it was still a little early to come to any conclusions about his results or felt one would have to wait a long time before being certain.

In 1977 Davies wrote:

In spite of criticisms from our orthodontic colleagues I feel that there is a definite place for a more radical approach to cleft lip and palate surgery. We have completed 155 cases repairing the lip and palatal clefts in one operation and the last fifteen cases have been neo-nates six days of age. Technically the operation is not a difficult one for the surgeon and providing that the anaesthesia is superb there does not appear to be any increased risk for the child. Eight of these cases needed no blood transfusion as their measured blood loss was less than 5% of their total blood volume. Neo-nates are very resilient as they are still protected by maternal antibodies and in fact from the physiological point of view the infant is more vulnerable at three months of age when most surgeons start their operative procedures.

Early radical surgery is ideally suited to the 75% of the world that is under supplied with medical care and has socio-economic problems unknown in the States. I was most interested to hear from Fernando Monasterio that his mobile units and the people that they have trained in outlying parts of Mexico have completed no fewer than 1000 radical repairs.
Brown and McDowell stated in 1945:

It is unfortunate that cleft lips so frequently coexist with cleft palate, causing many surgeons to be pre-occupied with closing part of the palate at the same time the lip is closed. Aside from the probability that early surgical treatment to the palate may result in unnecessary dental damage, it seems to us that good repair of the lip is difficult enough to require the surgeon’s individual attention in the process.

Of course, it depends on the circumstances involved in the specific case. If it is a question of “all at once” or “only a part ever,” then the “all in one” principle is the wiser choice. Under the usual modern conditions, speed or “all in one” is not the goal. The surgeon must design the number of stages, sequence of closures and optimal age for each, guided by his circumstances, his experience and that of the other specialty members of his team.
46. Personal Palatal Evolution

**KEY TO CODE ON CASES**

B.D. birth date

F.H. family history

F.T. first trimester

O.C.A. other congenital anomalies

Op operation

Ad adhesion

Adv advancement

Rot rotation

R-A rotation-advancement

H.P. hard palate

S.P. soft palate

B.G. bone graft

b-c back-cut

wr white roll flap

c flap c

col columnella

A cleft is indicated by stippling, a submucous cleft or submucous distortion by horizontal lines.
THIS chapter traces the evolution of my personal quest for a surgical solution to the cleft palate problem as exemplified by a sample of pertinent cases, many of which are the palatal follow-up of cleft lip cases presented in Volumes I and II. My actions were first influenced by training and later by experience. Observations of von Langenbeck procedures at Harvard and Vanderbilt in the mid-1940's revealed closure without lengthening and about a 70 percent good speech result. Kilner, Peet and Wardill in England in the late 1940's impressed me with the V-Y lengthening, and even without nasal lining release more than 75 percent obtained good speech but with some arch collapse. Brown, Byars and McDowell in St. Louis in the early 1950's demonstrated the Dorrance incision and radical nasal lining release during the pushback leaving large raw areas, but they obtained similar speech results and some arch collapse. My first cases combined V-Y lengthening with nasal lining release and left a raw area.

**PRIMARY SURGERY**

**V-Y PUSHBACK**

CASE 1 was born with a unilateral incomplete cleft of the lip and the palate but with an intact alveolus. In 1957 rotation-advancement of the lip cleft was successful.

In 1958, at age 1 year, a Kilner-Wardill type of three-flap V-Y pushback procedure was carried out leaving a portion of the nasal lining raw (stippling).

In 1960 Berkowitz first noticed a crossbite developing, on which he commented in 1963:
Unilateral crossbite of the right buccal segment due to medial collapse of the alveolus. Suggest expansion.

When seen in the cleft palate clinic in 1967, the patient was found to have normal speech and hearing, and a full-banded appliance was in place on both upper and lower arches. When last seen in 1977, the patient was a corporal in the army, with good occlusion and normal speech and hearing.

CASE 2 was born with an incomplete cleft of the lip, severe nasal distortion and a complete cleft of the hard and soft palate.

On 4-15-59 the lip was closed by means of the rotation-advancement method. On 3-23-60, at about 12 months of age, a vomer flap was used to close the anterior hard palate and a four-flap Wardill V-Y procedure achieved some pushback, leaving a raw nasal area at the junction of the soft and hard palate. A small fistula formed.

In 1966 the maxillary teeth were behind the mandibular teeth. In 1967 collapse of the cleft segment with crossbite necessitated placement of an upper, fixed lingual arch wire for maxillary expansion. On 6-18-68, following maxillary expansion, at the age of 9 years rib bone grafts were used as struts and chips to fit between the alveolar segments, overlay the arch and underlay the alar bases. In 1970 a palatal space retainer was adequate. Speech was normal. On 7-1-76, at age 17 years, a cleft lip rhinoplasty was carried out.

Bottom line: Concerned about the limited lengthening, the nasal lining raw area, the inevitable contracture and possible fistulae, I conceived the island flap method of pushback in 1960.

E A R L Y  P U S H B A C K  W I T H  I S L A N D  F L A P
UNILATERAL CLEFTS. CASE 3 was born with a cleft of the soft palate which was treated at 19 months of age with a horseshoe shaped pushback using a unilateral island flap taken from the anterior mucoperiosteum and
crossing the midline 1 cm. Thomas Cronin of Houston observed the surgery and admitted with a slight wince that there might be a place in palate surgery for the island flap.

Healing was uneventful, and at his first cleft palate clinic evaluation the patient presented normal speech but a slight hearing loss, otitis media, enlarged tonsils and adenoids and allergies. Conservative treatment including anti-allergic therapy was instituted, and in 1967 Pigott pronounced the patient a perfect speaker, a judgment endorsed in cleft palate clinic in 1969, 1970, 1972, 1975 and 1976. Orthodontic expansion by R. Litowitz was started in 1971 for a mild "hourglass" deformity with crossbite of the upper left second bicuspid amenable to orthodontia. When last seen in 1976 the patient had a long, mobile palate with normal speech. At that time photographs were taken of his palate at rest and elevated into a competent sphincter while phonating "Aaahh."

CASE 4 was born with a cleft of the soft palate which was treated at 1 year of age with a horseshoe shaped pushback, a right island flap being used to fill the nasal defect after release of the soft from the hard palate. At age 12 years the patient began orthodontic treatment for crossbite and at age 16 years was reported by Berkowitz to have excellent palatal arch development and good occlusion.
CASE 5 was born with a cleft of the soft palate extending into the hard palate. At 10 months of age a V-Y pushback was performed; a 1.5 cm. wide right island flap was used to fill the nasal lining defect after release of the soft palate from the hard palate edge. The levator muscles were detached from the edge of the hard palate, dissected into two bundles, retropositioned and sutured together into an intact loop. The surgery took 43 minutes.

From the age of 3½ years the patient has had normal speech, but Berkowitz noted a narrowing of her upper dental arch.

At age 6 years (1975), this record of the contracted arch was taken by Berkowitz; subsequently, a palate expander was used to spread the arch.
CASE 6 was born with a severe complete unilateral cleft of the lip and palate which was treated at 3 weeks by a lip adhesion with no undermining of the lateral lip segment from the maxilla. At 3 months of age the anterior cleft was closed with mucoperiosteal flaps from the cleft edge for nasal closure and excess mucosa from the lip adhesion for oral closure. At the same time, the lip was approximated with the rotation-advancement method. In 1971, at 14 months of age, a V-Y pushback was accomplished with a 1.5 cm. left island flap inserted into the release of the nasal lining.
Levator muscle attachments were freed from the hard palate edge, dissected into bundles and sutured into an intact muscle loop.

In 1973 the patient revealed mild right buccal and anterior crossbite, which was treated successfully with expansion orthodontia. In 1977, at age 7 years, speech was normal except for a lisp. Correct occlusion is being maintained by a retainer. Nasal correction at 16 years is planned.

**Bottom line:** Here, an early pushback with island flap achieved normal speech with only moderate maxillary crossbite, corrected early with orthodontia. But maxillary deformity is usually greater than in this case.

CASE 7 was born with an incomplete cleft of the lip, notch of the alveolus and cleft of the soft and the distal third of the hard palate. At 2 months of age rotation-advancement achieved lip closure. At 1 year a V-Y pushback of the palate used a right mucoperiosteal island flap, 1.25 cm. wide, to fill the nasal defect. The hamulus was fractured bilaterally, and closure of the palate was achieved in three layers with excellent healing.

When last seen at age 10 years, after Berkowitz removed the maxillary expander, the patient revealed a good arch and good occlusion with a long, mobile palate producing normal speech.
CASE 8 was born with a short, cleft soft palate. At age 2 years she had a V-Y palate pushback preserving an anterior V-wedge of mucoperiosteum. After release of the soft from the hard palate, a 1.5 cm. wide left island flap was inserted into the nasal lining defect. The levator muscles were freed from the hard palate, dissected into bundles and sutured into a retroposed, intact muscle loop.

<table>
<thead>
<tr>
<th>B.D.</th>
<th>12-29-69</th>
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<tbody>
<tr>
<td>FH.</td>
<td>No clefts</td>
</tr>
<tr>
<td>FT.</td>
<td>Uneventful</td>
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<tr>
<td>O.C.A.</td>
<td>None</td>
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CASE 9, showing a moderate cleft of all of the soft and a portion of the hard palate with thin soft tissue elements, was treated with a pushback using a unilateral island flap at 14 months of age, with no fracture of the hamulus. Peter Randall assisted.
At age 6 years basal and lateral view videofluoroscopic evaluations were conducted during isolated and connected speech. The lateral view indicated light contact, but the basal view was somewhat obscure, suggesting no contact in connected speech. Because the patient's speech was "incredibly" good, intensive speech therapy was instituted. At age 7 years speech seemed near normal and occlusion of the teeth was good, but an expansion wire was still in place.

CASE 10 was born with an incomplete unilateral cleft of the lip, an alveolar notch and a cleft of the soft and part of the hard palate. At age 3 months the lip was closed with the rotation-advancement method. At 11 months a V-Y pushback was done using a right mucoperiosteal island flap to fill the nasal lining defect. At 8 years of age the child has normal speech but requires maxillary expansion to improve occlusion.

CASE 11 was born with a complete unilateral cleft of the lip and palate. A lip adhesion was performed at 3 weeks of age to mold the maxillae and was followed with a rotation-advancement lip closure at 5 months. On 2-18-72, at age 10 months, the palatal arch molding and growth were good. On 9-1-72, at 16 months, the hard palate cleft was closed with a turnover vomer flap and the soft palate lengthened by a V-Y pushback using a right island flap to fill the nasal lining defect.
On 2-7-73, the palatal scar had brought the lesser segment medially intro buccal crossbite. Palatal form had stabilized by 9-6-73.

At age 4 years and again at 7 years speech reported normal

6-24-78 After orthodontia; excellent palatal development
Bottom line: The "early island" gave good speech in 80 percent of the patients, with minor orthodontic correction required in 70 percent. The maxillary distortion in some cases was so great that it not only troubled the orthodontist but may require a Le Fort I advancement in a rare case. This possibility is seen in a couple of the following four cases.

CASE 12 was born with an incomplete cleft of the lip but a wide cleft of the palate. At 2½ months rotation-advancement closed the lip and at 7½ months was followed by closure of the hard palate cleft with a vomer flap. At 18 months a V-Y pushback was performed with a right island flap inserted into the nasal lining defect. Normal speech was noted at 3 years, and speech is still normal at 13 years. Development of the maxilla was not so normal: This is one of the cases recorded by Berkowitz which caused me to stop the early island flaps!

Berkowitz noted:
The too-early island flap resulted in maxillary growth inhibition in all three dimensions. Both lateral segments were drawn medially, obliterating the palatal vault space. Anterior-posterior growth disturbance resulted in arch length deficiency with crowding of teeth and anterior cross-bite.

Orthodontia has begun to expand and advance the upper arch. Maxillary osteotomy may be required eventually if orthodontia cannot correct the deformity.
CASE 13 had a severe cleft of the lip, alveolus and palate with a deficiency of the maxilla and distortion of the nose. At 3 months of age rotation-advancement closure of the lip was carried out. The anterior palate cleft was closed at 18 months with a vomer flap. The patient had excellent arch form and palatal segmental relationship before the island flap, as seen in Berko-witz’ model.

At 21 months a V-Y pushback of the palate was achieved, leaving the V over the anterior closure untouched and taking a unilateral island flap for nasal lining. Nine months after palate surgery, models show the transverse palatal scar causing medial pull of the lesser segment and carrying the buccal teeth into crossbite.

Palatal expansion widened the arch, correcting the crossbite. On 11-10-70 an iliac bone graft was placed across the cleft. Removal of orthodontic retention permitted medial relapse of the lateral palatal segments, resulting in palatal narrowing and severe buccal crossbite (11-73).
After orthodontic advancement and expansion, occlusion was achieved in spite of the palatal scar, but fixed retention will be necessary to maintain arch form integrity (7-78). At age 10 years the patient had normal speech. Cephaloradiographs made in 1978 by Berkowitz show the velum contacting the pharyngeal wall with vocalization of u.

CASE 14 was born with a severe right complete cleft of the lip and palate with maxillary deficiency. At 4 months of age the anterior palate cleft was closed with a Burian flap and the lip with rotation-advancement. At 15 months maxillary expansion was started with a pinned screw plate, and at 20 months of age rib bone grafts were inserted across and into the cleft. At 2½ years, a V-Y palatal pushback was done using a left island flap to fill the nasal lining defect after release of the soft palate from the hard palate edge.
At age 12 years the patient has a long, mobile palate with good speech. The original deficiency of the maxilla, the bone graft at 20 months and the denudement of the hard palate by the island flap at 2½ years seem to have influenced maxillary development with resulting arch contracture and crossbite. Treatment by expansion springs has brought improvement in occlusion, but it is possible that the patient will require maxillary onlay grafts at 15 to 16 years.

CASE 15 was born with a complete unilateral cleft of the lip and palate with a severe nasal deformity. At 2½ months the anterior palate was closed with cleft edge mucoperiosteal flaps, covered on the nasal side by a mucosal flap of the inferior turbinate based inferiorly after removal of bone. At 3½ months the lip was closed by the rotation-advancement method, but without nasal tip correction. At 11 months the alveolar and anterior hard palate cleft was filled with a rib bone graft and covered with a Burian labial flap. At 18 months a V-Y pushback of the palate was performed using a unilateral right island flap.

When the patient was seen in cleft palate clinic in 1971 at age 5 years, the speech pathologist reported that speech was essentially normal. The orthodontist noted collapse of the maxillary segments and an anterior crossbite deserving orthodontic treatment.
Orthodontic expansion of the maxilla was started, with improvement in occlusion. This treatment will continue, and at age 16 years a corrective rhinoplasty will improve the boy's appearance.

![Images of dental and facial features after orthodontic expansion and occlusal correction.](image)

5-76 After buccal expansion and occlusal correction

At rest

"Aaahh"

After advancement, maxillary incisors are in proper overbite-overjet relationships. Note excellent arch form and good vault space.

Although a convenient, early anterior cleft closure and normal speech were obtained and intentions were the best, using the turbinate in the anterior closure possibly started maxillary collapse. Then the early bone graft may have retarded growth. Subsequent early denudation of the maxilla with mucoperiosteal flaps and an island further affected the maxilla so that its growth was abnormal. It is remarkable that orthodontia seems to be expanding the arch with correction of the occlusion.

**Bottom line:** The temptation of convenience of anterior cleft closure and early pushback with an island for good early speech must be resisted until maxillary growth has progressed to 5 years.

**BILATERAL CLEFTS—INCOMPLETE.** CASE 16 was born with an incomplete bilateral cleft of the lip and a cleft of the soft palate. At 4½ months of age a bilateral rotation-advancement closure of the lip, without columella lengthening, was done. At 28 months a V-Y pushback of the
palate, leaving a V anteriorly, was achieved using a 1.25 cm. wide right island flap to fill the nasal defect. The levator muscles were freed from the edge of the hard palate, dissected into bundles and sutured into an intact loop.

When the patient was seen in cleft palate clinic in 1972, at the age of 4 years, her speech was normal but a severe buccal crossbite of the molars was noted and orthodontic therapy advised. When seen in 1978 at the age of 10 years, she still had normal speech, but as no orthodontia had been used the crossbite was still present. The patient is now receiving dental correction.

BILATERAL CLEFTS—COMPLETE. CASE 17 was born with complete bilateral clefts of the lip and palate, a projecting premaxilla and almost no columella. Rubber band traction was started at 7 days, and at 3 months of age the lateral lip mucosa and muscles were joined in the midline behind the prolabium and a forked flap was banked in whisker position.

11-19-69 Before rubber band 11-26-69 During rubber band traction

8-7-70 After closure of lip and fork banking
Berkowitz described the condition of the maxillae after lip closure:

Excellent approximation of the premaxillary and lateral palatal processes with marked reduction in the cleft space.

Two and a half months later, on 4-23-70, the banked fork was advanced into the columella. 12-10-70, at age 13 months, a V-Y pushback was achieved using a right mucoperiosteal island flap to fill a 1 cm. nasal lining defect. Vomer flaps were turned laterally for nasal closure. The levator muscles were dissected free and sutured into an intact muscle loop. A postoperative suction test was positive.

In 1974 otological examination revealed fluid in the right ear and retraction of the left superior tympanic membrane. Bilateral myringotomy was followed by insertion of P.E. tubes. Cleft palate clinic evaluation of speech and hearing found no abnormalities in 1976 and again in 1978, but the orthodontist's report was not so happy. Berkowitz reported on the 1974 models:

After island flap and palatal cleft closure at 13 months, the resulting palatal scar tissue caused distortion with bilateral crossbite. Where the premaxilla was in extreme overjet at the newborn period, at the age of five years, the incisor teeth were in tip-to-tip relationship due to diminished anterior-posterior maxillary growth.

Maxillary expansion was advised.

**Bottom line:** In complete bilateral clefts, as in complete unilaterial clefts, extensive elevation of mucoperiosteal flaps before 5 years of age is contraindicated because of scar retardation of maxillary growth. In these double clefts it is possible that there will never be enough expendable mucoperiosteum for an island flap. Once the premaxilla and maxillae have been positioned normally and stabilized through the growth period (Latham-Georgiade approach), an island flap is sometimes available. At the
moment, despite the good speech with the primary island flap, I do not use it in bilateral clefs until the teenage years.

LATER PRIMARY ISLAND FLAPS (AFTER AGE 5 YEARS)

In certain cases the diagnosis or opportunity for operation may be delayed.

CASE 18 was born with a wide cleft of the soft and half of the hard palate. On 1-18-61, at about the age of 5 years, a V-Y pushback was achieved, taking a small atypical island flap for transverse lengthening of the nasal lining. A superiorly based pharyngeal flap was used primarily to close the nasal side of the soft palate cleft.
In 1967 cleft palate clinic evaluation reported class I bimaxillary protru­
sion with a lingual crossbite of the upper left first molar. Speech was normal.
Last evaluation in 1977 found teeth in good occlusion and speech normal.

CASE 19 was born with an apparently normal palate. Following T & A
the patient developed nasal escape in speech; cephalometric studies by
Berkowitz revealed an incompetent velopharyngeal sphincter at age 10 years.
Mobility seemed good, so on 5-9-73 a pushback of the palate was performed
with a bipedicle island flap inserted into the nasal lining defect. Healing was
uneventful, with the donor area of the island epithelialized in three weeks.
Speech pathologist Bensen reported a long, mobile palate with normal

CASE 20 was born with a submucous cleft palate with a V defect in the
hard palate, cleft in the muscle with mucosa intact and a bifid uvula.
Following T & A at 5 years the patient began to have nasal escape.
Cephalometric studies by Berkowitz revealed a 1 cm. gap between the velum
and pharynx on vocalization of u.

On 10-11-73, at the age of 6 years, a horseshoe-shaped incision was used
to dissect the mucoperiosteum. Bilateral neurovascular bundles were freed

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by sharp dissection, and a 1.5 cm. island flap cut free from the anterior portion was inserted into the nasal lining defect after division of the mucosa along the edge of the hard palate. The levator muscle attachments were moved back by the release but not dissected as discrete bundles. The hamulus was not fractured. A suction test was positive.

Cleft palate clinic evaluations in 1975 and 1977 found normal speech and hearing. The maxillary arch was narrowed and the vault space diminished. Buccal crossbite existed at both maxillary molars. In 1978 expansion wires to correct a maxillary hourglass deformity were in position. The palate was mobile and producing normal speech.

CASE 21 was born with a submucous cleft palate with a hard palate defect, cleft in the muscle, bifid uvula, short velum and nasal escape in speech. On 1-21-71, at age 6 years, a pushback was accomplished using an anterior bipedicle island flap transposed into the nasal lining release.
In 1975 orthodontic braces were used for maxillary expansion. In 1976 evaluation in cleft palate clinic found good occlusion with no crossbite and a long, mobile palate with normal speech. Photos taken in 1977 show the musculus uvulae contracting into an "inchworm."

CASE 22 was born with a submucous cleft palate which caused difficulty in speech. At age 10 years, the speech pathologist in cleft palate clinic noted excellent movement of the palate and lateral pharyngeal walls, a short palate, nasal escape and good articulation. On 10-20-76, at age 10 years, a portion of the translucent area of the velum was excised and the edges of the bifid uvula were pared prior to a three-layer closure of the soft palate. A horseshoe-shaped incision well away from the teeth allowed elevation of a mucoperiosteal flap. The anterior portion, taken as a bipedicle island flap, was used to fill the nasal lining defect after release of the soft palate from its attachments to the hard palate.
Two years after surgery the palate seemed slightly short; there was good speech with individual words and slight nasal escape in conversation. Cephalometric studies by Berkowitz revealed good velopharyngeal closure, but Dickson's nasendoscopy found a slit-like aperture during velopharyngeal closure for speech in the area of the right lateral port and a probable similar condition on the left. The posterior palate translucency indicated a thinness in this submucous cleft.
CASE 23 was born in Haiti with a cleft of the entire soft palate and two-thirds of the hard palate. The cleft was over 1 cm. wide at the greatest point and remained untreated until, at the age of 6 years, the patient was first seen presenting typical nasal cleft palate speech.

On 9-21-66 a V-Y pushback of the palate was carried out using a specially designed bipedicle island flap for nasal lining.

In 1967 Pigott studied this palate with his early method of endoscopy eight months postoperatively and reported only minor nasal emission. Speech therapy was advised.

In 1971, 1973 and 1974 the patient was evaluated in cleft palate clinic by all disciplines and reported to have normal speech, normal hearing and normal occlusion. He was last seen in 1978 with an excellent result.
CASE 24 had always had difficulty with speech. At the age of 30 years, evaluation in the cleft palate clinic reported:

Gross nasal emission is present on all consonants. . . . He uses the substitution of a glottal stop for many phonemes. He is now expressing a concern [about] the low degree of intelligibility. There is suspicion of congenital palatal insufficiency.

Cephalometric studies by Berkowitz revealed an A-P gap of at least 1 cm. On 5-30-73 a V-Y pushback was performed, the nasal lining defect being filled with a 1.25 cm. wide right island flap. The details of the surgical steps were recorded photographically.

Anterior island donor area marked
Horseshoe-shaped incision being made
Mucoperiosteal flap dissected off bone

Freening left neurovascular bundle for pushback
Releasing nasal lining from hard palate (No. 11 BP blade)
Freening island neurovascular bundle (No. 15 BP blade)

Cutting the mucoperiosteal island free
Island poised to go into nasal defect
Key sutures in the distal ends of island for placement in defect
Island sutured into nasal defect

30 yrs.

Postoperatively: At rest (above) and positive suction test (below)

Even when a potentially normal palate is constructed at age 30 years, speech therapy is indicated to eradicate bad habits.

**Bottom line:** The later primary island flap achieved good speech results in a high percentage of cases but with much less arch and dental distortion. The fortunate delay in surgery in these cases was due in great part to the late diagnosis of submucous cleft palate.

**PRIMARY PHARYNGEAL FLAP**

There are certain cases with palatal paralysis, large cleft defect, huge velopharyngeal gap or unavailable island flap in which a primary posterior pharyngeal flap may be of benefit.

CASE 25 revealed speech difficulty to the parents at 2 years of age. At cleft palate clinic the diagnosis of paralysis of the velum was treated by a speech aid ineffectively. On 6-4-69, at age 7 years, a 1 cm. superiorly based pharyngeal flap was attached to the upper surface of the velum and the raw flap partially covered with a turnback mucosal flap from the uvula.

On 9-13-70 our speech pathologist noted some improvement but recorded nasal escape on all fricatives and on some plosives in conversation. On 4-20-71, at age 9 years, a second, wider (2 cm.) superiorly based pharyngeal flap was attached along the free border of the velum and again partially covered with a turnback mucosal flap from the uvula. This maneuver was carried out just beneath the previous pharyngeal flap and without disturbing it. On 11-26-73 the patient stated that her speech had improved so much that speech therapist Bensen saw her only once a year.

**Bottom line:** A paralyzed velum usually requires a wide pharyngeal flap.
CASE 26 had a congenitally short palate with good levator action but incompetent velopharyngeal closure. The patient was treated at age 12 years with a 1.5 cm. wide superiorly based pharyngeal flap attached to the nasal side of the velum. One year postoperatively, speech was normal except for a slight articulation problem of w/r substitution.

CASE 27 was born with a normal-looking palate but a large nasopharynx and velopharyngeal incompetence. The problem was first treated with speech therapy, which only frustrated the patient. At age 13 years a 2 cm. wide pharyngeal flap was inserted into a fishtail incision along the posterior border of the velum and on the upper surface of the uvula; a mucosal turnback flap was used to cover the raw undersurface of the pharyngeal flap. In 1969 cleft palate clinic, the speech pathologist reported normal word production without nasal escape and with good prognosis for speech therapy. A parental report in 1978 stated that the patient can speak as well as he wishes, has a job and is getting married.

CASE 28 was born with a wide cleft of the hard and soft palate. On 3-9-61, at the age of 3½ years, a primary superiorly based pharyngeal flap was used for nasal lining of this large defect. Von Langenbeck incisions allowed release of the mucoperiosteal flaps for oral closure.
Two months after surgery the pharyngeal flap seemed to tether the velum and restrict motion. Division of the flap was contemplated but postponed. In 1963 evaluation of speech in cleft palate clinic revealed a large number of minor sound substitutions, notably f for s and w for l. It was thought that maturation would improve speech without therapy, and, in fact, speech was within normal limits in 1973.

CASE 29 was born with a wide, horseshoe-shaped cleft of the soft and hard palate and a deficiency of tissue. On 4-3-74, at 3 years of age, a primary 1.25 cm. wide superiorly based pharyngeal flap was turned into the entire nasal defect. A V-Y mucoperiosteal flap pushback was carried out. The levator muscle attachments were freed from the edge of the hard palate and sutured into an intact loop, and the oral side was closed with mattress sutures.

Examination of the patient in 1978 revealed a mobile palate with good speech having a slight hypernasal quality but no difficulty with s's.

CASE 30 was born with a wide cleft of all the soft and part of the hard palate. This person received no treatment until, at 28 years of age, he joined the police force. An island flap pushback was planned, but during surgery no discrete bundles were found so the nasal defect was filled with a T-shaped superiorly based pharyngeal flap.
Ten years later the patient’s speech is nearly normal, with minimal nasality causing him no difficulty in his work. He has advanced to the rank of police lieutenant.

CASE 31 had a rather wide cleft of the soft palate, which was short. Treatment included a variation of the T pharyngeal flap. At age 2½ years closure of the cleft and lengthening of the palate was achieved without dissecting mucoperiosteal flaps and endangering maxillary growth. A superiorly based pharyngeal flap was split at its distal end. As the flap was sutured into the nasal side of the cleft, the split ends fitted into the lateral releasing incisions in the nasal mucosa along the posterior edge of the hard palate.

*Bottom line:* The pharyngeal flap may be *the flap of last resort,* but in severely deficient cases like these it is *a flap of great import.*

**CONSERVATIVE PRIMARY APPROACH**

In view of the effect on maxillary growth and development and dental occlusion caused by early denudation of bone, elevation of mucoperiosteal flaps was reduced to a minimum until the age of 4 to 5 years.
CASE 32 was born with a cleft of the soft palate, which was also short. At 9 months of age simple splitting of the cleft edges allowed closure of the velum in three layers. When seen in cleft palate clinic at age 7 years, the patient revealed a short, mobile palate. The speech pathologist noted excellent mobility, normal resonance balance and articulation, absence of hypernasality and mild hoarseness. Speech therapy was advised. Nine months later the patient had a T & A. At cleft palate clinic 10 months postoperatively her speech was borderline normal, indicating that she will probably succeed with speech therapy.

CASE 33 was born with a soft palate cleft which was closed at 1 year of age by a procedure simply splitting the cleft edges and closing in three layers. This included freeing the levator attachments from the edges of the hard palate and, after dissecting them into discrete bundles, suturing them into a retropositioned (1 cm.) intact loop.

Bottom line: This approach handles the muscles in a more sophisticated manner than was used in the previous case and should give minimal distortion with a good chance of normal speech.
CASE 34 was a complete unilateral cleft of the lip, alveolus and palate treated at 1 month of age with P.E. tubes, soft palate closure and a lip adhesion. Six months later rotation-advancement of the lip was completed. At age 2 years a vomer flap and von Langenbeck incisions allowed closure of the hard palate. Evaluation at 4 years revealed that speech was progressing well.

CASE 35 was born with an incomplete unilateral cleft of the lip, an abutting cleft of the alveolus and a cleft of the hard and soft palate. At age 3 months P.E. tubes were inserted, the soft palate edges were split and approximated and the lip was closed by rotation-advancement. At 7 months a vomer flap closed the anterior hard palate. At 3½ years von Langenbeck incisions and freeing of mucoperiosteal flaps allowed division of the levator muscle attachments to the hard palate edge so the muscles could be dissected free, retroposed about a centimeter and sutured into an intact muscle loop. The cleft in the soft and hard palate was then closed in three layers.
The patient returned from Alaska for a checkup in 1978 at age 5 years to reveal good appearance, good speech and good occlusion.

CASE 36 was born with a severe complete cleft of the lip and palate, a deficient lateral lip element and extreme nasal distortion.

On 12-11-74, at 2 months of age, a lip adhesion was accomplished using an I flap to release the lateral alar base and the short vestibular lining. P.E. tubes were inserted after myringotomy, but the soft palate cleft was too wide for closure. The adhesion was effective for six months, until 6-4-75, when rotation-advancement of the lip was achieved along with soft palate closure.
On 7-14-76, at about 21 months, a vomer flap was turned for hard palate nasal lining. Von Langenbeck mucoperiosteal flaps were dissected and the aponeurosis and levator muscle attachments divided from the hard palate edge, allowing the soft palate a slight posterior lengthening when the muscles were sutured.

When the patient was seen in 1978 at the age of 4 years both lip and palate seemed to be functioning well. It was noted that the child would return from Colorado at age 5 years, at which time minor nasal correction would be important for school. If speech is not found adequate at this time because of palatal shortness, an island flap pushback will be considered.

CASE 37 was born with a complete unilateral cleft of the lip and palate. At 6 weeks myringotomy with insertion of P.E. tubes and a lip adhesion procedure were done, but the cleft in the palate was too wide for closure. Rotation-advancement closure of the lip was performed at 9 months and followed with soft palate closure at 18 months. The cleft edges were split and the levator muscles dissected, divided from the anterior attachments to the posterior edge of the bone and sutured into an intact loop, achieving a 1 cm. retropositioning. At 2½ years the cleft in the hard palate had narrowed enough so that nasal mucosa and oral mucoperiosteum could be dissected and closed in two layers without elevation of large flaps.
At age 5 years the child needed orthodontia to spread the maxillary arch. Speech was good despite a cephalometric study showing a slight velopharyngeal gap. He may need an island flap later.

CASE 38 was an Ecuadorian patient born with a complete cleft of the lip and palate. At 3 months P.E. tubes were inserted, the soft palate was closed and a lip adhesion was done. At 6 months the definitive lip closure was achieved by means of the rotation-advancement method. At 2 years of age the hard palate was closed with a vomer flap turned over and tucked under the opposite mucoperiosteal edge of the cleft.

Cleft palate clinic evaluation in 1978 at the age of 4 years found excellent velar and lateral wall motion, good resonance balance and an anterior lisp with every indication of normal speech to come.
CASE 39 was born with a complete unilateral cleft of the lip and palate. At 2 months P.E. tubes were inserted, the posterior soft palate was closed and the lip was approximated with an adhesion. At 6½ months definitive lip closure was achieved with the rotation-advancement method. At 16 months the hard palate was closed with a vomer flap and the remaining soft palate approximated, leaving a fistula at the junction. At 3½ years modified von Langenbeck incisions around the maxillary tuberosities allowed dissection of mucoperiosteal flaps and closure of the remaining opening.

Evaluation in 1977 cleft palate clinic at age 4½ years revealed a short palate functioning well, with closure against the adenoid pad and good progress in speech therapy. The patient’s occlusion was excellent except for a "slight crossbite of upper left deciduous cuspid" with no need for orthodontia. In 1978, again in cleft palate clinic, no changes were noted in dental condition and speech was reported normal.
CASE 40 was born with a left complete unilateral cleft of the lip and palate. At 5 weeks a lip adhesion was performed, mobilizing only the medial element. At age 6 months the soft palate edges were split and sutured, and the lip was closed with rotation-advancement. At age 1 year a vomer flap was turned over for nasal closure of the hard palate cleft. Von Langenbeck incisions allowed total oral closure of mucoperiosteal flaps.

At age 5 years, cleft palate clinic evaluation revealed excellent maxillary development with upper left deciduous cuspids in crossbite but posing no problem. When the patient was last seen in 1978 at age 7 years, a maxillary expander was in position with good arch form. The palate was short but moving well, with intermittent nasal escape. The patient is able to close the sphincter now, but when the adenoids shrink at about 11 years he may need a pushback with an island flap.
CASE 41 was born with a severe unilateral complete cleft of the lip and palate. At 2 weeks of age a lip adhesion molded the maxilla and at 4½ months the lip was closed by the rotation-advancement method. At 1 year of age the soft palate was closed in three layers. At 17 months the hard palate cleft was closed with a turnover vomer flap tucked under the opposite cleft edge. On 2-23-77 basal and lateral view videofluoroscopic evaluations were made during isolated speech sounds and connected speech. Both lateral and basal views indicated very good velopharyngeal motion and somewhat discoordinated velopharyngeal closure. Intensive speech therapy for a period of one year was advised. In 1978, at age 6½ years, clinic evaluation repeated this recommendation. The orthodontist reported excellent buccal occlusion but found the anterior teeth developing in anterior crossbite or tip-to-tip relationship, meriting close observation and eventual orthodontia.

**Bottom line:** This regimen of early lip adhesion, soft palate closure at 1 year and hard palate closure at 17 months with no mucoperiosteal flap elevation and no palate lengthening has resulted in minimal, easily correctable orthodontic problems and borderline speech, often with enough velopharyngeal contact to make normal speech possible with the aid of intensive speech therapy.

CASE 42 was born with a severe complete bilateral cleft of the lip and palate and a projecting premaxilla. At 7 months of age the soft palate was closed.
closed by splitting the cleft edges and suturing in three layers. At the same
time the bilateral cleft lip was closed with union of the muscles across the
cleft and banking of the forked flap. At 18 months of age bilateral vomer
flaps were turned over for nasal closure and bilateral von Langenbeck
incisions facilitated the dissection of bipedicle mucoperiosteal flaps, which
made closure on the oral side possible.

At 5 1/2 years the banked forked flaps were used to lengthen the columella
and free the nasal tip. The father reports from Europe that at age 6 years the
child is doing well in school and that “her speech is perfect.” She is now
starting orthodontic treatment.

CASE 43 was born with a complete unilateral cleft of the lip and palate.
At 7 weeks a lip adhesion was achieved, but the palate proved too deficient
for closure. At 8 months the edges of the soft palate cleft were split and
sutured and the lip was closed by the rotation-advancement method. The
maxillary arch, molded by the lip adhesion and definitive closure, facilitated
hard palate closure employing a vomer flap and unilateral von Langenbeck
incision at 16 months. Excellent arch form is present at 18 months.
Bottom line: This conservative approach achieves early coordination of soft palate and velum, as well as hard palate closure before 18 months without wide mucoperiosteal dissections.

In the following case there was such a wide cleft that a conservative velar adhesion had been used primarily and the residual gap threatened to require the aid of a pharyngeal flap.

CASE 44, first operated on in central Florida, had had a wide cleft of the soft and hard palate partially closed with a velar adhesion at age 2 years. At age 5 years the residual defect was still huge. Freeing of the nasal mucosa from the bony edge of the cleft allowed closure of this layer except for a 0.5 cm. hole at the anterior end. The levator muscles were dissected from the posterior bony edge, repositioned and sutured into an intact muscle loop. Then a variation was used to achieve oral closure without tension, especially at the anterior end. A von Langenbeck incision on the right and a V-Y type of flap on the left facilitated shifting of a mucoperiosteal flap over the anterior hole with sound closure, bypassing the need for a pharyngeal flap.
SECONDARY SURGERY

SECONDARY ISLAND FLAP PUSHBACK

It was estimated in the conservative approach that the arch collapse and malocclusion would be greatly reduced and easily amended with orthodontia, but that only 70 percent of patients would get normal speech. Thirty percent (or more) would require an island flap pushback at 5 years or older. This regimen thus seemed acceptable.

CASE 45 was born with a cleft palate, closed in Boston at 14 months of age. At age 5 years the patient revealed nasal escape during speech.

On 8-14-62, at 5 years, an anterior bipedicle island flap was used in a pushback of the palate for a 1.5 cm. lengthening. The palate was well healed two months postoperatively. Final evaluation in 1976 at 19 years revealed an active, mobile palate producing normal speech and good occlusion.

CASE 46 was an Ecuadorian girl with a failed cleft palate closure, who revealed nasal escape when seen at age 8 years. An island flap was taken from the anterior portion of each side of the mucoperiosteum, sutured to the other and inserted into the nasal lining defect after a pushback of 1.7 cm. A 1.25 cm. wide superiorly based pharyngeal flap was let into the bifid uvula. A suction test was positive.
CASE 47 was born with a complete unilateral cleft of the lip and palate, treated in infancy in Tennessee. The palate was short, allowing nasal escape in speech. In 1968, at age 12 years, a secondary V-Y pushback was performed using 2 cm. wide left island flap to fill the nasal lining defect after release of the soft palate from the hard palate edge. Within two months after the pushback surgery the patient was speaking normally. In 1977, at age 21 years, the transverse palatal scar had caused some palatal migration of the bicusps. Cephaloradiographs by Berkowitz soon after the island flap pushback surgery and nine years later show good elevation and contact with the posterior pharyngeal wall, consistent with the action that can be seen directly during speech.
CASE 48 was born with a cleft of the soft palate which was closed at 4 months of age following splitting of the cleft edges and suturing in three layers. Cleft palate clinic evaluation in 1977 found good velopharyngeal activity with speech attempts characterized by mild to moderate hypernasality. In April 1978, nasopharyngoscopy by Pullen and the Dicksons found good velar and lateral wall motion with a rectangular velopharyngeal gap approximately 5 mm. in anteroposterior direction and 2 mm. in lateral direction. The lateral walls were observed to nearly meet with effort on the production of /slks/. Total closure was not achieved during any speech samples elicited.

Assessment: Velopharyngeal activity is inadequate for balanced resonance, presenting a persistent 5 × 2 mm. aperture during the production of fricative-vowel-consonant-fricative speech samples which prognosticates poorly for sustained and adequate closure during connected speech.

On 5-19-78, at age 5½ years, a palatal pushback was done with an anterior 1.5 cm. bipedicle island flap inserted into the nasal lining defect. A small (Stellmach) superiorly based pharyngeal flap was inserted into the nasal side of the uvula for an adhesion. Postoperative suction test was positive.
**Bottom line:** Early simple closure was not quite enough, so a pushback with an island enabled the velum to function in closure. A small pharyngeal flap adhesion offered a “hand-up” to the velum, reducing the lift excursion for better efficiency at little cost.

CASE 49 was born with a left complete cleft of the lip and palate treated at 1 month with a lip adhesion. At age 4 months rotation-advancement closed the lip, using 1 flap for nasal closure over turnback mucoperiosteal flaps from the alveolar cleft edges for nasal floor reconstruction. At 10 months the edges of the soft palate were split and sutured, and at 2 years a vomer flap closed the hard palate defect.

At age 5 years evaluation revealed a short, mobile velum and active lateral walls but hypernasal speech. The upper left cuspid was going into crossbite. In 1977, at age 6 years, a V-Y pushback leaving an anterior V over the previous cleft area and placing a right island flap into the nasal defect achieved a 1.5 cm. lengthening.
In 1978 the patient had a slight upper left cuspid crossbite, to be treated by Berkowitz. Both isolated and connected speech were normal.

CASE 50 was born with a complete unilateral cleft of the lip and palate. A lip adhesion at age 1 month separated and was resutured five days later. At 6 months rotation-advancement closed the lip. At 16 months the soft palate was closed, and at 2 years a vomer flap was turned for hard palate closure. At age 4 years, because of nasal escape in speech, a V-Y pushback was performed, an island flap being inserted into the nasal lining defect. After one year of speech therapy the patient’s speech was good enough to discontinue therapy. Orthodontia was in progress at age 7 years to give moderate maxillary arch expansion.
CASE 51 was born with an oblique unilateral incomplete cleft of the lip and complete cleft of the alveolus, hard palate and soft palate. On 5-8-73, at 5 months of age, lip closure by rotation-advancement and soft palate closure by splitting and suturing the edges were accomplished.

On 5-8-74 at nearly 18 months, a vomer flap was turned over and tucked under the opposite mucoperiosteal edge of the cleft to close the hard palate in one layer. A small fistula remained at the junction of the hard and soft palates.

In 1975 the patient revealed good occlusion except for a crossbite of the left cuspid. Speech was unintelligible. In 1976 cephalometric evaluation by Berkowitz revealed velopharyngeal closure and good motion but a small soft palate and a thin, contracting adenoidal mass. The speech pathologist recorded nasal escape.

On 6-14-77, at about 4½ years, mucoperiosteal flaps were elevated on each side of the cleft and an island flap was developed on the right. The neurovascular bundle was freed on the left and the nasal lining divided, as were the levator muscle attachments from the posterior edge of the hard palate, allowing the soft palate to move posteriorly 1.5 cm. The island flap filled this defect, and the mucoperiosteal flaps were advanced posteriorly in V-Y manner to close the fistula and cover the island flap. The suction test was positive at the end of the operation.

When seen in 1978 the patient had perfectly normal speech without nasal emission, and only the left deciduous cuspid needed to be brought into normal labial position.
Bottom line: The reduction in scar contracture of the maxilla and the amount of required orthodontia seems to justify a delay in normal speech development in some cases. At 5 years an island flap can lengthen the palate and obtain normal speech with maxillary impunity.

A TERTIARY PPF STEP

CASE 52 was born with a cleft of the palate which was evidently treated at 8 months and again at 18 months by surgery elsewhere. When seen at age 6 years the child had a short palate and marked nasal emission during speech. In 1969, at age 6, a V-Y pushback was performed with a 1.5 cm. right island flap inserted into the nasal lining defect after release from the hard palate. Improvement in speech was noted, but nasal emission continued. At 8 years of age, therefore, a small anterior residual fistula was closed in two layers and a 1.4 cm. wide superiorly based pharyngeal flap inserted on the superior aspect of the soft palate and into a split along the posterior edge of the velum. In 1977 cleft palate clinic at the age of 14 years, the speech pathologist reported, “Speech is normal.”

CASE 53 was born with Pierre Robin syndrome, including a cleft of the soft palate. Glossoptosis with respiratory distress was treated effectively with a Kirschner wire through both mandible angles and the tongue. At 14 months of age a V-Y pushback was achieved, inserting a right island flap into the nasal lining defect.

In April 1978, at age 10 years, nasopharyngoscopy by Pullen and the Dicksons revealed lateral wall motion to be minimal and velar motion good, with occasional touch contact. Connected speech samples showed near but not complete closure, with an opening narrow in the anteroposterior direction and broad in lateral dimension, as shown in the diagram, producing hypernasality in both isolated and connected speech samples.
edges of the velum. Velar mucosal turnback flaps were used to cover the raw underbelly of the pharyngeal flap. Speech improved postoperatively.

Note the normal development of the mandible and minimal need for orthodontia of the maxillary teeth.

CASE 54 had a submucous cleft palate which developed speech difficulty after a T & A. At 5 years of age a bipedicle island flap pushback achieved a 1.25 cm. lengthening but with negative suction test results. Cephalometric evaluation revealed a 0.75 inch gap in velopharyngeal closure and hypernasal speech.

At age 7 years a 1.5 cm. wide pharyngeal flap based superiorly was attached to the velum with reduction in nasal escape except in connected speech.

At 9 years lateral recess flaps were transposed transversely across the posterior pharyngeal wall (Hynes). At the same time a V-Y upward advancement of the pharyngeal flap base was done (Hirshowitz). The suction test was positive, and near normal speech followed.

In 1979, David and Wilma Dickson gave a possible explanation for the prolonged difficulty of this case:

Our best guess is a supranuclear lesion somewhere within the extrapyramidal system, perhaps in the corticobulbar pathways, perhaps involving the cerebellar system. Our reasons for this are: (1) no observable peripheral pathology; (2) no paresis or other signs of pyramidal tract involvement; (3) normal function when operating "cortically"; and (4) reduced or absent velopharyngeal function during rapid or spontaneous speech and whenever his attention is distracted. In a sense this behavior is exactly the opposite of that found in dyspraxia or apraxia. Other possible explanations include a very subtle lower motor neuron pathology or involvement of the proprioceptive feedback system. The patient is being referred to pediatric neurology for further testing of both motor and sensory integrity.

**Bottom line:** Some cases need help from both ends, so never give up.
SECONDARY PPF

Some secondary cases with only a pharyngeal flap are presented.

CASE 55 was born with a complete unilateral cleft of the lip and palate, receiving primary surgery in Virginia. Secondary deformities included a constricted nostril, a lip without landmarks, a retropositioned maxilla and a short palate with nasal escape during speech. At age 13 years the mobile but short and scarred palate was benefited by a 1.5 cm. wide superiorly based pharyngeal flap which was let into the nasal side and posterior edges of the velum. The raw underbelly of the flap was covered by a mucosal turnback flap from the upper surface of the velum and uvula. Subsequently iliac bone grafts to the maxilla, orthodontia, a midline Abbe flap and cleft lip rhinoplasty achieved a pleasing result. At age 17 years the patient had good occlusion, good speech and a good appearance.

CASE 56 was a 9-year-old boy who had received speech therapy since kindergarten. He revealed a submucous cleft palate with a bifid uvula, a midline cleft in the muscles and hypernasal voice quality during connected and isolated speech. On 1-4-78 Pullen and the Dicksons, using a Machida nasendoscope, visualized the velopharyngeal aperture, noting good velar and lateral wall motion during speech. Yet closure was incomplete at the midline for all samples of speech tested, particularly for high vowels and fricatives. There was a marked curvilinear depression at the velar midline, precisely where the uvular bulge is expected to produce closure. This was their assessment:

<table>
<thead>
<tr>
<th>B.D.</th>
<th>9-21-68</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.H.</td>
<td>No clefts</td>
</tr>
<tr>
<td>F.T.</td>
<td>Uneventful</td>
</tr>
<tr>
<td>O.C.A.</td>
<td>None</td>
</tr>
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</table>

13 yrs.
The midline velar depression results in incomplete velopharyngeal closure at midline; air escape is observable through this "hole" during isolated and connected speech samples, but not during swallowing. Since velar and lateral pharyngeal wall motion were clearly adequate except for midline closure, it is recommended that surgery be concentrated on this specific area—a narrow pharyngeal flap should suffice.

On 1-23-78 the edges of the bifid uvula were pared and the soft palate was divided in the midline. Levator muscle fibers were freed from the hard palate edge, dissected into bundles and sutured into an intact loop. A 1.3 cm. wide superiorly based pharyngeal flap was let into the longitudinal muscle defect on the nasal side to bolster the area of weakness. The pharyngeal wall donor area was closed with 3-0 Vicryl mattress sutures.

Five months later, evaluation in cleft palate clinic by the Dicksons revealed competent closure with good speech in isolated words, including s, but speech therapy is required to complete the correction in connected speech.

Bottom line: This is the kind of coordination of diagnostic and surgical teams that will eventually solve most palatal problems.

CASE 57 was born with a severe unilateral complete cleft of the lip and palate and mucous pits of the lower lip. At 3 months rotation-advancement closed the lip, and at 8 months alveolar mucoperiosteum was elevated so that split rib grafts could be inserted into and across the cleft. At 10 months the soft palate was closed, reducing the hard palate cleft so that at 2 years it could be closed with a vomer flap. The mucous pits in the lower lip were excised at this time. Speech was reasonable until the patient had a T & A which resulted in nasal escape during conversation. At 7 years a wide superiorly based pharyngeal flap was attached to the upper surface of the velum and along the posterior edge, facilitating normal speech. Orthodontic correction by Silver was being maintained with a retainer at age 15 years. A corrective rhinoplasty at age 16 years completed reconstruction.
CASE 58 was born with isolated cleft palate, treated elsewhere with a Wardill pushback at age 2 years and another pushback with a pharyngeal flap at 8 years. When first seen in our cleft palate clinic at age 12 years, this girl still had incompetent velopharyngeal closure with nasal escape.

On 4-15-70 there was no evidence of the first pharyngeal flap. A second, 2 X 3 cm. superiorly based pharyngeal flap was attached nasally to a split in the soft palate.

Speech pathologists' 1974 evaluation at age 16 years reported essentially normal speech.

*Bottom line:* The velar-pharyngeal synechia may not be physiological but it often works.

Here is a modification in technique for attaching a wide superiorly based pharyngeal flap to the superior surface of the velum and laterally along the posterior pillars. It does not require splitting the entire velum, and there is a cosmetic advantage as the pharyngeal flap is hidden by the intact uvula.

**Both Island and Pharyngeal Flap**

Finally, when the tissues are deficient or the velopharyngeal gap is large, the island flap pushback and a complementary posterior
pharyngeal flap can be used simultaneously to lengthen the palate (belt) and reduce the velopharyngeal gap (suspenders). An additional advantage of the pharyngeal flap synechia is its “hitching post” function, which keeps the velum up and close to the posterior pharyngeal wall at all times and thus reduces the length of excursion and the amount of velar lift required by the levator muscle for more efficient sphincter control.

CASE 59 had an incomplete cleft of the soft palate treated in infancy. After adenoidectomy at age 5 years, the patient began to have difficulty with speech and was treated with a pharyngeal flap. The attachment, however, became disrupted and left a large central defect in the velum which was responsible for nasal emission. Contraction of the levator muscles presented limited lift of the velum because of their attachments to the hard palate edge.

At age 29 years the mucoperiosteum was elevated from the hard palate through a horseshoe-shaped incision. Both neurovascular bundles were dissected free to create an anterior bipedicle island flap 2 cm. wide. The soft palate was divided from the edge of the hard palate with a pushback of 2.1 cm., and the island was sutured into this defect. The levator muscles were dissected into bundles and sutured to each other to form an intact loop. A 1.4 cm. superiorly based pharyngeal flap was inserted into the nasal side of the split velum and uvula. Healing was uneventful.

Sixteen months postoperatively, referring surgeon Gary Russolillo of Hartford, Connecticut, wrote:

Your patient has progressed marvelously and during an evaluation at the University of Connecticut Medical Center Speech Therapy Department was informed that she had such excellent speech that further therapy would be of no benefit to her. She indeed has a marked change in speech, noted both in personal contact and over the phone. Prior to surgery it was difficult to understand her on the phone and in person.

CASE 60 was born with a soft palate cleft, treated elsewhere at age 12 years with a pushback using a horseshoe-shaped incision. At age 19 years the patient revealed a short, mobile palate with a large velopharyngeal gap. The speech pathologist in cleft palate clinic reported a short palate with extreme
hypernasality but excellent articulation. On 1-16-78 a horseshoe-shaped incision at the line of the old scar allowed elevation of a mucoperiosteal flap. Bilateral dissection of neurovascular bundles produced a bipedicle flap of anterior mucoperiosteum which was turned over to fill the nasal lining defect after release of the soft palate from the hard palate edge. The old scar of the soft palate was opened, and a 1.4 cm. wide superiorly based pharyngeal flap was inserted on the nasal side.

Six months after surgery there was a long, mobile palate which already made for much improvement in speech and good production of s's. Speech therapy is in progress.

CASE 61 had an isolated cleft of the palate which was closed elsewhere with the von Langenbeck method. The result at 17 years of age was a mobile but short velum with marked nasal escape.

On 2-7-78, by means of a Dorrance incision, an anterior bipedicile island flap was used to fill the release in nasal lining. A small superiorly based pharyngeal flap was attached to the split in the uvula. The suction test was positive.
On 6-16-78 the palate appeared long and mobile. Nasal escape in speech was still present but diminishing. The patient is to have speech therapy.

CASE 62 was born with a complete unilateral cleft of the lip and palate. The lip was closed at 6 months and the palate at 18 months in Boston. At age 10 years this boy revealed buccal crossbite which was under orthodontic expansion. His palate was mobile but short and scarred, producing hoarse, hypernasal speech.

On 3-24-78 at age 12 years a 1 × 2 cm. superiorly based pharyngeal flap was sutured into a split on the superior surface of the distal velum and uvula as an adhesion. Bilateral mucoperiosteal flaps were elevated on either side of the previous cleft and the neurovascular pedicles dissected. A 1.25 cm. island flap was cut free on the right and turned over into the nasal lining defect after release of the soft from the hard palate. The remaining mucoperiosteal flaps were advanced posteriorly in V-Y fashion and sutured over the island flap. Uneventful healing was followed by speech therapy and normal speech.

Bottom line: When the palate is mobile and short, with an anteroposterior gap of no more than 1 cm., a pushback with an island flap is considered more physiological. If the gap is greater than 1 cm., then a pharyngeal flap can be used in conjunction with the island flap. If the gap is extremely large, a wide pharyngeal flap may be necessary. Remember that too much reduction in nasal air flow causes destructive changes of the nasal mucosa, reduction in lung function and hyponasal speech.

Of course, there are other ways of achieving good results. This chapter is but a study of the successes and failures of one surgeon over 21 years.
VI. Fistulae and Failures and Their Management
TOTAL healing by first intention is the goal of the palate surgeon, but invariably there are occasional failures. Yules' 1970 review of the world literature revealed the following failure figures: 16 in 101 (R. McClelland and T. Patterson, 1963); 15 in 158 (A. Jolley and J. Savage, 1963); 36 in 123 (J. Smith, W. Huffman, D. Lierle and K. Moll, 1963); 16 in 89 (R. Trauner and F. Doubeck, 1955); 2 in 12 (B. Williams and F. Woolhouse, 1962); 26 in 190 (L. Bernstein, 1967) 2 in 20 (D. Robinson, M. Byrne and W. McClelland, 1955); 4 in 79 (J. Owsley and H. Blackfield, 1965).

The occurrence of secondary fistulae in the palate anywhere along the site of the original cleft represents failure of surgical closure. The tract soon becomes epithelialized, with a resultant avascular scarring around the hole. The most common causes of fistulae are: inadequate approximation of the opposing raw surfaces, which may result from failure to evert one or both edges of the wound; necrosis of the end of a flap used in closure; tension; infection; careless suturing; and traumatic disruption of the healing wound. Through the years, the most effective closure of a fistula has been in two layers, without tension, in the absence of infection, using flaps with adequate blood supply fixed with mattress sutures and protected during the healing phase.

A fistula draws attention first because the hole allows embarrassing escape into the nose of fluid, food and, if large enough, air during speech. Yet the size of the hole, like the proverbial visible peak of the iceberg, does not tell all. Holdsworth, in his final 1970 edition, pointed an accusing finger at fistulae:
Scar which aggregates with repeated operation makes it [ palate] short, and
deforms the arch. Even when a small perforation heals itself, contraction of
scar about the hole renders the palate short.

He also warned about a positive throat swab:

To operate in the presence of staphylococci, or β hemolytic streptococci
belonging to Lancefield’s group A, is inexcusable, nor can a week on
penicillin or any other drug be trusted to clear the organisms. . . . With a
postoperative upper respiratory tract infection, there is mechanical irritation
and edema of the wound edges, which may impair healing.

There have been numerous reports of fistulae resulting from
partial failure in cleft closure. In 1941 Oldfield reported a 10
percent occurrence. In 1960 Ross Musgrave and John Bremner of
Pittsburgh reviewed 780 cleft palate operations over a 10-year
period (1950-1959) and noted defects in primary healing result­
ing in fistulae in 5 percent. They reported:

The second stage operation for bilateral clefts gave the most difficulty with
repair, the incidence of a healing defect being 20 percent. Defective healing
was less common in unilateral clefts (7.7 percent) than in bilateral (12.5
percent). The fewest complications were encountered in the incomplete cleft
palate group (4.6 percent).

Closure of a fistula often can be extremely difficult for the very
same reasons that caused its occurrence in the first place. To
compound the complexity, further inadequacy of local tissue and
subsequent postoperative scarring can be added.

**NON-SURGICAL TREATMENT**

In 1967 Obermeyer advocated a cauterization technique using
tincture of cantharides to help heal palatal fistulae in the imme-
diate postoperative period. He reported 60 percent success out of
139 cases during an eight-year period, with 33 percent showing
improvement and 7 percent being refractory. Certainly this treat-
ment will intensify the scarring whether it closes the hole or not.

In 1977 Milton D. Berkman and M. L. Lewin of Montefiore
Hospital in New York reported seven patients 2 to 24 years of
age with oronasal fistulae treated with a vinyl palatal appliance
inserted within a two-week postsurgical period and worn continuously until closure of the fistula. They reported:

Treatment results in six of seven patients demonstrated complete closure within a two to three month period with no recurrence. In one patient, the fistula narrowed significantly.

**SURGERY**

The mucosal or mucoperiosteal hinge flap swinging from one edge of the fistula, covered by a second mucoperiosteal flap, is a most popular approach toward closure. This type of closure was described by Krimer in 1827.

**von Langenbeck**

In 1864 von Langenbeck described a sophisticated two-layer closure of a fistula with a turnover hinge flap for the nasal side and von Langenbeck lateral incisions for bilateral strap flap closure of the oral side.

**Fitzgerald**

Naghten Fitzgerald designed several one-layered hinge flap closures. In 1875 he wrote:

According to the size of the chink, I take a corresponding piece of mucous membrane and tissue down to the bone; from one side this is dissected from without inwards and made to hinge at the margin of the opening. . . .
Should the opening be very large, I take the wing or shutter from each side and stitch them in the center . . . The great secret is to have the wings larger than the opening, so that there may be no tension to interrupt the circulation.

Wassmund

In a 1973 book by Schuchardt, Steinhardt and Schwenzer, a chapter by Luhr, Höltje and Hammer presented various two-layer methods by Wassmund, described in 1939. One was a modification of Krimer’s method. Another used sliding mucoperiosteal flaps, while another used a labial sulcus flap. All had nasal lining turned from the edges of the fistulae.

Other labial sulcus flaps

Of course, the Burian upper labial sulcus flap can be used to close anterior alveolar fistulae. Then Peter Egyedi of the University of Utrecht, the Netherlands, described a method for closing fistulae in the difficult area around the premaxilla. Many years before, while working in Liberia, West Africa, he had learned the value of cleft surgery. He recalled:

Once in Africa the husband of a lady with a cleft told me, after I had closed the lip, that her value had increased at least three chickens and one goat, because of her better appearance.

Thus in 1976, in the Journal of Maxillofacial Surgery, he noted:

It is always necessary to use vestibular flaps in the alveolar region . . . Two flaps, one from each side, may be necessary for this purpose, but necrosis of
the tip of such flaps made us try the bucket-handle flap.

Even this bipedicled flap can become necrotic... The flap is raised including as much submucous tissue and periosteum as possible... The flap is swung over the intermaxillary bone and sutured into position after excision of the margins of the defect... No attempt at obtaining a nasal layer behind the intermaxillary bone was made... In the case where the cleft behind the intermaxillary bone has the shape of a Y, the dorsal extension of the cleft cannot be closed unless it is very short. The bucket-handle flap could be extended as depicted.

Egyedi admitted:

An obvious disadvantage of the flap is the lowering in vestibular height in the region of the intermaxillary bone and the presence of the two pedicles on top of the alveolus. Therefore one should include a secondary correction of the vestibulum in the treatment planning.

He reported that the bucket-handle flap had been used in five cases with four flaps surviving and one becoming necrotic in its medial one-third.

Holdsworth

Surgeons have continued to use these general principles, occasionally installing some modification. William Holdsworth was one of my early palate teachers and was working on the first edition of his book, *Cleft Lip and Palate*, published in 1951 when I was at Rooksdown House. He was an expert with the hook in his huge hands and could evert inaccessible edges with great skill for suturing. His advice for closing fistulae involved two-layer closure:

It is important that the nasal mucosa be closed as a separate layer, and that in both layers the closure be free from tension.
These simple, concise diagrams are typical of his book and represent the standard approach to fistulae in various positions.

Reid

In the 1962 *British Journal of Plastic Surgery*, astute Campbell Reid of United Sheffield Hospitals gave Hynes credit for a 1955 personal communication introducing the hinge flap for closure of slit-like fistulae and smaller holes. He noted:

The principle of this procedure is to raise a mucoperiosteal flap immediately adjacent to the fistula based along one edge and to turn this as a hinge over the hole so that its buccal surface will lie uppermost in the fistula. . . . A slot is then prepared into which the free edge of the overturned flap may be fitted. This is achieved by a minimum number of three mattress sutures. . . .

The hinge flap method of closure has been used with success in a number of small fistulae of the hard palate, *i.e.*, those less than 2 cm. in diameter. Sometimes a recurrent fistula has appeared, though smaller than the original. This is most likely at either end and results from a technical fault. The procedure may, however, be repeated after an interval when the small hole may be readily closed, using a flap from the other side. The distressing symptom of fluid regurgitating down the nose is effectively controlled.

Gabka

Joachim Gabka of Berlin in his 1964 book outlined two-layer fistula closure with inturning of the edges for the nasal side. He presented diagrams of V-Y mucoperiosteal flaps for closure of an anterior hole. A sliding mucoperiosteal flap was advocated for an
anterior split. A rotation flap was shown for a posterior hard palate fistula. A V-Y was again shown to close both an anterior slit and a posterior round hole in the hard palate simultaneously.

**Randall**

Randall, for Goldwyn's *The Unfavorable Result in Plastic Surgery*, commented:

Fistulas in the hard palate are much more difficult to close than they seem.

He showed diagrams of a modified von Langenbeck approach for a two-layer closure of a mid-hard palate fistula and a unilateral rotation flap, aided by a labial mucosal flap for a more anterior fistula.

**Oneal**

Robert Oneal of Ann Arbor, in *Cleft Lip and Palate*, edited by Grabb, Rosenstein, and Bzoch, presented a method of handling the various fistulae appearing in the three standard positions. An anterior vestibular-alveolar fistula was closed with a vomer flap (A), lateral nasal flap (B), and oral-gingival mucoperiosteal flap (C).

A hard palate fistula was closed with lateral edge turnover flaps for nasal closure covered by rotation of a flap of mobilized mucoperiosteum.
A soft palate fistula was closed by lateral relaxing incisions and complete mobilization of hard palate mucoperiosteum plus in-turning of fistula edges for nasal closure and three-layer suturing.

Rintala

Aarne Rintala of Finnish Red Cross Hospital, Helsinki, in 1971 described a new method using two hinge flaps at the edges of the fistula. One hinge flap (A), barely the size of the fistula, was elevated, freed from the bony edge with care not to perforate, and turned over to form the nasal layer. A similar flap (B), somewhat larger than flap A, was drawn on the contralateral side of the fistula but, before elevation, was denuded of epithelium by scalpel or abrader. Flap A was sutured to the opposite edge and then overlapped by flap B, which was also sutured. The operative area
was dried and covered with Squibb Orahesive Bandage, an elastic membrane that adheres to mucosa, and the patient was kept on a liquid diet for a fortnight. Rintala reported 30 successful fistula closures, the largest being 2 cm. in diameter. The only complication of this two-layer closure had been hemorrhage from the exposed raw area, which epithelialized in three to five weeks, and which would, of course, have produced some cicatricial constriction. This was counteracted by a prosthesis in patients of growing age.

Tongue flaps
In 1901 von Eiselsberg mentioned that Gersuny had discussed with him the possibilities of transplanted pedicle flaps from the tongue to close defects of the palate. The two cases in which von Eiselsberg attempted tongue flaps ended in failure. In 1904 Ranzi and Sultan of Billroth's and von Eiselsberg's clinic reported that the seven cases of cleft palate in which a tongue flap had been used terminated in failure and that this method should only be resorted to when no other was available. Undoubtedly, the problem was a lack of immobilization of the tongue during healing.

Guerrero-Santos
José Guerrero-Santos of Guadalajara, Mexico, appreciates the tongue as a donor area. In 1966 in *Plastic and Reconstructive Surgery*, he and J. T. Altamirano advocated a wide, distally based dorsal tongue flap for closure of hard palate fistulae. The scar was excised around the edges of the palate hole; then one or more turnover palate flaps were used for nasal closure, prior to covering the defect with a lingual flap. The tongue was held to the upper
lip and dental arch with a wire suture. In this first presentation, they reported 10 patients with hard palate fistulae caused by noma, bullet wound, tumor and incomplete cleft palate closure.

By 1967 at the Congress in Rome, Guerrero-Santos, with Garay, Torres and Altamirano, had increased the experience to 28 cases of palate fistulae treated by the same tongue flap method. Evidently, movement of the tongue had proved to be a problem because they described tongue immobilization with triple fixation. First, the tongue flap was attached over the fistula. Then a small distal tongue flap was sutured to a labial flap. Finally, a Kirschner wire was passed through one angle of the mandible, transfixing the tongue, and out the other mandibular angle.

In 1973 in the *Cleft Palate Journal* Guerrero-Santos, with Fernandez, offered an alternative two-stage method to avoid tongue movements dislodging the final palate attachment. A unilateral dorsal tongue flap, based distally, was waltzed to the inside of the cheek on the same side. Once this joint had obtained a blood supply, the tongue attachment was divided and the flap was swung up to close the fistula in the palate.
In 1972 Hector Marino wrote of a trick he had found valuable in fixing a tongue flap into the scarred, avascular area of a palate fistula. He advocated passing a strong nylon suture through the tongue flap and then through the fistula and out the nostril, to ensure flap apposition to the palatal defect.

Previously, these large anterior palatal defects have been closed by a prosthetic method or complicated multi-staged surgical procedures with poor results. This technique . . . can accomplish closure in two stages within three weeks of time . . . and the esthetic results have been excellent.

The results of the Templin-Darley Diagnostic Test of Articulation showed the lingual flap procedure to have no adverse effects on articulation. . . . No statistical differences were found between the patients and the control subjects in respect to the vertical lingual movements, and no statistical differences were noted between the two groups in lingual diadochokinetic abilities.

In 1972 Ian Jackson, and in 1973 Jackson with Hannelore Sieber of Glasgow, Scotland, in the British Journal of Plastic Surgery, confirmed the value of the Mexican tongue flap for closure of anterior palatal fistulae in children. They described inturning of the edges of the fistula for nasal closure and suturing the tongue flap to the sides of the defect, allowing the unused portion to tube itself. The design of this flap was outlined:
It is 5 or 6 cm. long and its width may be two-thirds of the dorsal aspect of the tongue.

They did not feel that further postoperative fixation, other than the attachment of the flap, was necessary.

In his 1975 Flemish book A. J. C. Huffstadt presented these photographs of an anterior hard palate fistula, which he closed with the aid of a distally based dorsal tongue flap similar to what Guerrero-Santos and Ian Jackson had used.

Basket cases

In 1976 a University of Virginia team of five (Golden, Mentzer, Fox, Futrell and Edgerton) attributed their success with 31 tongue flaps to the support and protection of an aluminum suspension basket wired to the teeth for 21 days until the pedicle was divided.

Contrary to Jackson (1972), we believe that gentle but exacting support of these flaps is the single most important determinant of survival.

It is likely that the blood supply of the flap and the recipient area and the method of apposition of the two with sutures is of first priority.

In 1978, in Cirugia Plástica Argentina, Miguel Correa-Iturraspe and Hector Luis Panigatti of Buenos Aires proposed a posteriorly based dorsal tongue flap to fill a large, scarred, central palatal defect. Flaps turned in from the sides provided the nasal lining and the tongue flap produced cover. In the second stage, when the base of the tongue flap was divided, it was attached posteriorly by overlapping it with a superiorly based pharyngeal flap.
In the early 1960's, when the island flap was being used for nasal lining in pushback procedures as a primary operation at 18 months, unless great care was exerted in the anterior nasal closure of complete clefts, an anterior hard palate fistula would form. Use of the anterior mucoperiosteum for the island meant that there was less immediate tissue available in the vicinity of the fistula. Although more difficult, it was usually possible to maneuver mucoperiosteum for adequate closure. In one such case, local tissue failed and a tongue flap was used successfully.

Previous tongue flaps had been designed with the donor area on the dorsum where the taste buds and sensation are pronounced. It seemed more kind and economical to take the flap from the anterior ventral aspect with the base placed just beneath the tip. It turned up in an action not unlike that of an old bullfrog flicking flies with its tongue. The edges of the fistula were turned in, and the ventral tongue flap was flipped up into the anterior defect quite easily, requiring no extra fixation. The donor area closed without difficulty. This flap is suited only for anterior fistulae.

A variation

In the early 1960's, when the island flap was being used for nasal lining in pushback procedures as a primary operation at 18 months, unless great care was exerted in the anterior nasal closure of complete clefts, an anterior hard palate fistula would form. Use of the anterior mucoperiosteum for the island meant that there was less immediate tissue available in the vicinity of the fistula. Although more difficult, it was usually possible to maneuver mucoperiosteum for adequate closure. In one such case, local tissue failed and a tongue flap was used successfully.

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Bone-grafting the fistula

In 1972 Ian Jackson of Canniesburn Hospital, Glasgow, went a step farther in fistula treatment by advocating stiffening the closure with bone grafts. His method involved opening the lip for revision, turning flaps from the vomer and the lateral walls of the fistula to close off the nasal side and using both Veau mucoperiosteal flaps and an anterior buccal mucosal flap for oral closure. As he noted in 1976:

Prior to complete closure bone chips from the iliac crest are inserted to fill the area between the palatal shelves and alveolar margin of the defect; the nasal floor is thus elevated. Bone is also inserted under the alar base, along the front of the hypoplastic maxilla and into the lateral wall of the pyriform fossa. To achieve a good occlusal relationship, patients, when necessary, underwent either presurgical orthodontic treatment or a simultaneous Le Fort I osteotomy.

It was found that many of these cases demonstrated improvement of their velopharyngeal incompetence. Forty-four such cases were submitted to speech assessment and the results reported by Mary S. Jackson, Ian T. Jackson and F. B. Christie in 1976. All patients, they noted, had immediate speech improvement, the majority moving up one category in the assessment scale. This was their summary:

Even the small anterior buccal fistulas had an underlying large bony defect. Once this defect was filled with a bone graft the tone of the voice was immediately improved whether the fistula was large or small. Creating a complete bony structure appears to alter resonance and thereby reduce nasal tones. A pre-alveolar fistula cannot be adequately sealed by an obturator; air is expelled into the nose whenever the lip loses contact with the prosthesis and speech improvement can be heard when the lip is pressed back against
it. It follows therefore that in secondary cleft palate repairs in patients with speech defects and an anterior fistula, it is not sufficient to restore velopharyngeal competence and fit an obturator; the fistula must be solidly closed.

In 1977 at the Toronto Congress, James A. Lehman, Jr., of Akron, Ohio, reported closure of anterior palate fistula with the use of a Burian type gingival labial flap. As he said:

We have found that this flap in combination with bone grafting has produced a very reliable technique for closure of large anterior fistulae. This has been used successfully in over thirty cases to date.

**Caution about simple fistulae!**

In 1975, at the New Orleans meeting of the American Cleft Palate Association, David G. Bowers of Vanderbilt University, who trained with Gerald O'Connor, called attention to the changing status of postoperative palatal fistulae. This is his abstract:

The character of palate fistula occurring after cleft palate repair is changing. Pushback palatoplasties leave more fistulae, and the location of the fistulae is usually in the most anterior portion of the cleft at the alveolar ridge rather than at the junction of the soft and hard palate as in past decades. Maxillary orthopedics to expand collapsed arches, often open more widely any previously unrecognized or asymptomatic fistulae, so their repair becomes necessary.

An analysis of repairs of 35 patients with a 48% failure rate and 46 operations with a 60% failure rate suggests the need for a drastic change in thought concerning the simplicity of closure of palate fistulae. Discussions
with experienced, established and well-recognized plastic surgeons also reveal
a high rate of failure of fistula closure and an awareness of the change in the
most common location of the fistula. . . . Recommendations include two
stage cleft palate repairs to prevent fistulae and delay of palate flap procedure
prior to closure of the fistulae.

Other flaps
The island flap has been found useful by some for closure of
fistulae. When the hole is enormous, flaps have been and can be
brought from a distance. Later chapters will be devoted to these
procedures.

Conclusion
It is important to note that each fistula deserves a specific plan.
Although most of the standard designs have been presented, the
choice of the correct approach for each case calls for experience,
care and patience.
48. Palatoplasty with Other Tissues
Within the Mouth and Nose

The posterior pharyngeal wall has been the most popular donor area, with the posterior pillars of the fauces second. Even the tongue has been found useful in rare occasions. Mucous membrane flaps from the cheeks and lips have also been employed.

Cheek Flaps

In 1829 Dieffenbach restored a velum destroyed by scrofula with a flap from the cheek. In 1862 von Langenbeck used the mucosa of the cheek as a flap to assist in partial closure of a large palatal defect. In 1869 Delorme closed a defect in the anterior hard palate by a pedicle flap of mucous membrane from the cheek and lip. In 1917 Rosenthal described the use of a quadrilateral cheek mucosal flap turned under alveolar and palatal mucosal flaps for nasal lining to a large posterior defect. He trimmed the alveolar ridge to facilitate introduction of the flaps, as shown here.

Blair

In 1911 Vilray Blair of St. Louis utilized the cheek in various ways to assist in cleft palate closure. He used quadrilateral cheek flaps based medially to advance inward during cleft closure. He also designed cheek flaps (X) to transpose around the maxillary tuberosities to fill secondarily the palatal relaxing incisions necessary to close a central defect.
Blair’s experience in primary and secondary palate surgery was most extensive, and his clear mind always allowed him to evaluate the problem logically. Usually, what he said in the early 1900’s is still pertinent today. Take, for instance, this statement:

I believe the following are causes for failure in cleft palate operations: too early operation; insufficient freeing of the tissue; inaccurate approximation with sutures; destruction of blood supply by cutting the lateral arteries and, most common of all, infection.

Brophy

In 1915 Truman Brophy of Chicago, in his book *Oral Surgery*, described the use of relaxing incisions in the buccal mucosa to obtain two bipedicle flaps for medial advancement to close a large hard palate fistula.

In 1923 Brophy endorsed Sir Arbuthnot Lane’s use of cheek and soft palate mucosa as a long flap to be turned over, tucked into the split edge around the hard palate fistula and fixed with quilted mattress stitches. Brophy reported:

I have made these operations on many patients, nearly always with good results.

The hole was closed, of course, but imagine the scar contraction and distortion with reduction in function of the soft palate.

Padgett

In the truly large secondary defects of the palate in which a part of or an entire mucoperiosteal flap had been lost, Earl Padgett of Kansas City called upon any local area available for a two-layer closure. His cheek flaps were more daring than those of Blair,
who had taught him the principles of this radical secondary work. His 1948 book with K. L. Stephenson presented some exciting local flaps. He used a lateral cheek flap based posteriorly, which he tucked under one of the von Langenbeck mucoperiosteal flaps for nasal lining during closure of the total defect. His adherence to such principles as double-layer closure particularly in the scarred palate explained his success and sometimes even justified his radical actions.

In unilateral deficiency or losses of mucoperiosteal flaps, he ingeniously used only one von Langenbeck flap from the uninvolved side and then called upon a posterior pharyngeal flap and a cheek flap. The cheek flap was based anteriorly or it was based posterolaterally, depending on the defect.

Schmid

In 1960 E. Schmid of Stuttgart advocated a cheek mucosal tube pedicle to be used to close fistulae of the hard palate.
O'Connor

Gerald O'Connor of San Francisco recalled in 1973:

Among the hundreds of operative procedures Gillies did while I was with him, I remember a palate case that we saw in which he said:

"Jerry, this is the rare case that surgery cannot help and should have a prosthesis."

It was a very wide post alveolar cleft of the hard and soft palate with very little soft tissue to work with and a small, extremely angulating cleft of the bony palate. Being very inexperienced, I agreed, as to me, his word was law. Little did he or I think then that in 1931 I would conceive a method of repair using his own baby "the tube pedicle" intraorally to correct the defect.

In 1972 O'Connor and McGregor presented the method of using one or two intraoral tube pedicles of cheek mucosa (2 × 6 inches) for large secondary palatal defects. The center of the flap was left attached during the first stage of the tubing. They called attention to the fact that their original case dated back to 1931, and then presented a more modern example in which a large
secondary defect involved hard and soft palate. First the anterior palatal defect was closed with mucoperiosteal flaps. Then a left cheek mucosal tube pedicle was constructed, attached to the palate defect and later used to close the hole, resulting in intelligible speech.

In 1964 F. Burian of Prague described a mucosal flap taken from the upper labial sulcus which could be used as a second-layer closure of the alveolar cleft. This same flap, as noted by Egyedi, may also cover a fistula behind the intermaxillary bone in bilateral clefts.

In 1976 Egyedi designed a plan for fistulae not totally unlike that of Ganzer in 1917, which described “a broad bipedicled flap from the lip” to close gunshot holes “in the anterior part of the alveolar process.”

Egyedi’s bucket-handle mucosal flap taken from the upper labial sulcus as thick as possible, including submucosal tissue and periosteum, was advocated for closure of difficult fistulae around the premaxilla. Egyedi reported five of these flaps with necrosis of only one and total closure of three of the fistulae.

Cheek flaps for nasal lining

M. M. Mukherji in 1969 and A. C. Ganguli in 1971, both of Calcutta, described cheek mucosal flaps for use on the nasal and oral side of defects between the soft and hard palates after pushback. In 1975 E. Kaplan of Stanford also advocated the mucosal cheek flap for nasal lining during palate pushback.

LIP FLAP

In 1836 Regnoli closed an oronasal communication with a mucosal pedicle flap from the upper lip based on the cutaneous septum of the nose. In 1839 Diday reported Sanson’s use of a reverse pedicle flap from the lip to close a hole in the anterior portion of the palate as a secondary cleft operation. In 1917 Rosenthal described a large mucosal flap from the upper labial sulcus (a) to be turned over into a huge anterior defect (b) and tucked under the peripheral edges (c).
Padgett in the late 1930's, as presented in his 1948 book, used an anterior sulcus mucosal flap for nasal lining of the anterior fistula in conjunction with a von Langenbeck procedure.

**TONGUE FLAP**

In 1975 in *Annales de Chirurgie Plastique* H. Cadenat, M. Fabie, R. Combelles, M. Clouet and A. Bernes of Toulouse described a primary tongue flap for the severe horseshoe-shaped palatal defect. In the first stage a distally based dorsal tongue flap was sutured into the anterior palatal defect. Twelve days later this flap was extended to the tip of the tongue and divided. A superiorly based pharyngeal flap was turned forward and attached to the velum, leaving a raw undersurface which received the extended tongue flap for oral cover.

**NOSE**

*Septal flaps*

In 1851 Gay used the nasal septum in a case of unilateral cleft lip and palate after the lip had been previously closed. In 1872 Lannelongue performed a uranoplasty in a wide cleft, utilizing a portion of the vomerine mucoperiosteum which was continuous with the border of the defect. In 1890 Sabatier moved the nasal
septum to the horizontal plane of the palatal vault. His procedure consisted in sectioning the septum from its attachment to the base of the skull by chisel and breaking it at its junction with the palatal plate. Once in a horizontal position, the septum was held with sutures to the denuded free border of the palatal defect. In 1897 Wildt reported a case by Bardenheuer in which a full-thickness septal flap was turned to close a palate defect following unilateral resection of the maxilla. In 1901 von Eiselsberg used the vomer and its mucoperiosteum to close a unilateral cleft in the palate.

In 1903 Foederl, after having experimented on the cadaver, reported success with a full-thickness septal flap turned into a unilateral defect of the palate following carcinoma excision.

In the late 1930's Sir Harold Gillies hinged a whole-thickness flap of the septum in a primary cleft palate closure when the child was still in the growing age. The primary object of filling the palatal gap was successful, with the development of perfect speech. Yet the nose remained juvenile and flat, causing us to write in our 1957 book:

This was one of the occasions when the secondary defect created in search of a cure was almost as disastrous as the original condition.

In fact, correction of this nasal deformity required a hinged hip graft, an ox cartilage implant, a nasal inlay graft, a small tube
pedicle, a Wolfe graft and finally a forehead flap rhinoplasty with a dermatome graft to the brow defect!

**Turbinate flaps**

In 1895 Kraske used the inferior turbinate bone to close a cleft palate in which lack of tissue made the classic operation of his time impossible. Resecting the inferior turbinate from before backward and keeping the posterior pedicle but cracking its bone to allow maneuverability, he attached the flap along one side of the cleft. Two weeks later the pedicle was divided, so that the turbinate could be moved to fill the entire defect. Kraske pointed out that both inferior turbinate bones could be used in cases in which the cleft in the hard palate was extensive. He also advised removing the turbinate bone so as to have only mucoperiosteum for cases with cleft velum.

In 1910 Gault used the mucoperiosteum from the inferior turbinate as a flap to close an anterior defect in the hard palate.
49. Distant Skin Flaps for Palatal Defects

There have been far more distant pedicles transferred to the palate than one would ever imagine. When the primary surgery has been well executed or the cleft is standard, no such pedicle gymnastics are necessary, but severe clefts, poor surgery, failure in healing and multiple secondary procedures may use up the local tissue. As anywhere else in the body, if local tissue is not available, distant tissue must be brought in to fill the defect.

Cheek

In 1868 Thiersch used a full-thickness pedicle flap from the cheek to close a gunshot wound of the hard palate. The defect was satisfactorily closed, but hair grew on the palate at the site of the skin surface of the cheek flap. It is easy to imagine the patient’s dismay as his small palatal mane whisked down his throat on inspiration and flew out his mouth on expiration.

In 1916 Rosenthal, finding the von Langenbeck method inadequate for large defects, designed a nasolabial cheek flap not unlike that of Thiersch with an inferior base for introduction into the palatal defect and aided by a local mucoperiosteal flap.

In 1918 J. F. S. Esser designed a nasolabial flap (ABCD), based inferiorly, incorporating the angular artery. The flap was introduced into the mouth through incision AB with the skin surface pointed toward the tongue. The borders of the palatal defect were denuded, and the flap was attached with bronze sutures. The bite was held open until the flap was well healed; then the pedicle was
divided and the cheek defect closed. In 1928 Esser was still using this nasolabial flap and described a case.

This patient had a hole 1½ cms. in diameter in the middle of the hard palate, surrounded by scar tissue. In this case a large massive flap, 10 cms. long and 3 cms. wide in its largest part, is cut, with pedicle in the cheek 2 cms. away from the corner of the mouth. A perforation of the cheek is made . . . and through this, the whole flap is passed, until the distant end reaches the hole in the palate, which it serves to close.

In 1918 Schlaepfer noted that Payr had attempted several times and failed to close palatal defects with a neck flap of skin and platysma muscle lined with a Thiersch graft. In 1918 he allowed the neck flap to granulate before it was transferred to the palate, fixed the flap into the cleft with sutures and succeeded in closing the defect.

In 1918, again, Kappis closed a palatal defect, 2 cm.² in size, with a neck flap lined with a Thiersch graft. The same year Kausch attached a chest flap to the tip of a finger of a soldier and covered the raw area of the flap with a Thiersch graft before transferring the flap to the palate. In 1920 Halle lined a nasolabial flap with a Thiersch graft prior to inserting it into a palate defect.

In 1930 Padgett was not intimidated by the size of the palatal hole. He used whatever tissue was available around the edges of the defect, brought in a pharyngeal flap from behind, then used upper buccal sulcus or cheek flaps to complete his two-layer closure.

In 1959 Karl Schuchardt of Hamburg used the Esser inferiorly based nasolabial skin flap to close a palatal fistula, drawing attention to the value of dividing the angular vessels near the inner canthus so they could be raised in the flap.

In 1966 Antony F. Wallace of Chelmsford, Essex, endorsed the Esser nasolabial skin flap for palatal defects and outlined the indications:

(a) The fistula is too large to close with local mucoperiosteal flaps, or these have been tried and have failed.
(b) The patient is edentulous, or has a gap between the teeth through which the skin flap can be introduced.
(c) The upper alveolus has atrophied and the upper denture, in the absence of adequate suction, either will not stay up or slips about inside the mouth.
(d) The beard area does not extend higher on the cheek than the level of the palate.
(e) The patient is prepared to accept a scar in the nasolabial line.

Wallace presented three cases that fit his criteria and suggested:

The nasolabial flap can reach well beyond the midline and should usually be taken from the larger side of the face when, as is often the case with old clefts, it is asymmetrical. Provided that the cheek is perforated by blunt dissection no facial nerve damage need occur. The parotid duct can always be avoided. Ectropion is not a problem and the facial scar is unobtrusive.

In 1969 Nicholas Georgiade, with R. A. Mladick and F. L. Thorne, of Duke University, endorsed tunneling the nasolabial skin flap for defects of the palate. They also emphasized the value of a superior base for this flap, noting that the flap can be wider than the inferiorly based Esser flap without fear of ectropion. If the flap is hair-bearing in the male, epilation is possible later. The flap was taken from the nasolabial fold closest to the defect and was made slightly larger than the defect. Mucosal or mucoperiosteal flaps were turned in around the fistula for nasal lining and, if this was not possible, a skin graft was used to line the flap. The
operation can be completed in one stage by denuding the portion of the base that fills the tunnel, but Georgiade prefers to divide the pedicle in a second stage. An excellent example of their approach was presented in *Plastic and Reconstructive Surgery*.

**FOREHEAD FLAPS**

In 1880 Nussbaum outlined an operation similar to that of Blasius in which he used an oblique frontal forehead flap based on the medial brow, measuring 9 to 12 cm. or whatever the palate cleft required. He passed this pedicle through an incision at the lateral side of the nose to be sutured into the palatal cleft with its raw surface up. Once the flap had adhered to its palatal attachment, it was divided and returned to the forehead.

In 1889 Rotter used a midline forehead flap which he lined with a Thiersch graft eight days prior to transferring the lined flap into a cleft in the palate. After another eight days, he divided the pedicle at the incisor teeth and replaced the remaining pedicle on the forehead.

In 1892 the German Bardenheuer described a rather complicated four-flap method of closing palatal clefts. First he turned a vertical forehead flap based on the lip, extending up between the inner canthus and the root of the nose, and fed it into the palatal cleft through one nostril all the way back to the posterior
The tail end of the forehead flap was received by an inferiorly based pharyngeal flap. The cleft edges of the palate were freshened and, with the aid of lateral von Langenbeck relaxing incisions, sutured together to overlap the forehead flap. Later the pharyngeal flap was detached and folded on itself to form a shelf-like projection on the posterior pharynx. The tail of the forehead flap was folded together to create a uvula.

This approach, although rather radical, seems remarkable for its time.

**NECK FLAPS**

In 1911 Vilray Blair described a 2-inch-wide vertical neck flap incorporating skin, superficial fascia and platysma muscle which could reach the cleft in the palate with its base below the cheek. He introduced his flap into the mouth through an incision at the buccalveolar cul-de-sac, and the defect in the neck was closed by undermining and suturing. The patient's bite was kept open while the flap was in continuity with the neck. After 10 days the pedicle was divided. Blair reported one case treated in this manner in which the velum functioned as satisfactorily as if the von Langenbeck procedure had been used.

**NECK AND CHEST**

In 1922 A. Luxenburger, preferring a flat plug to fill the palate cleft, bypassed the tube pedicle and used two flaps. One was taken from the skin of the neck behind the sternocleidomastoid and
over the trapezius, with its base upward and its apex at the clavicle, measuring 12 cm. wide. The second came from the chest below the clavicle, with its base upward and its apex at the anterior fold of the axilla, measuring $12 \times 5$ cm. The chest flap was turned under the neck flap as a double pancake and kept flat between cardboard splints. It was eventually attached to the cheek and later introduced into the palate cleft. One entire side was attached first, and the neck pedicle was finally divided to let the double flap be fastened along the opposite side of the cleft. Luxemburger suggested that bone from the pelvis or scapula might be implanted between his two flaps prior to moving the total component into the palate. Evidently he never carried out his threat.

In 1930 Padgett, trained by Blair, also used the chest-neck region as a donor area for a pedicle flap he lined with a Thiersch split-skin graft. Its first attachment on the way to the palate was on the mucosal side of the lateral lip element in an unoperated cleft lip. Next came detachment from the neck and insertion into the palatal cleft prepared for its reception by the turning of cleft edge flaps and a pharyngeal flap.

**ARM FLAPS**

In 1901 A. F. von Eiselsberg raised a long pedicle flap from the left forearm with its base at the elbow, which after seven weeks, when the edges had rolled into a tube, was denuded along its sides and introduced into the palate cleft. The arm was held up in position by a plaster bandage and the pedicle divided in 10 days, but the speech in this case was reported not improved.
In 1917 Rosenthal described the use of a pedicle flap from the flexor surface of the upper arm for large palatal clefts. He folded the pedicle on its base as the first stage and later introduced it through the entrance of the anterior nares after the nose was freed and rolled upward.

**LITTLE FINGER**

Anton Freiherr von Eiselsberg, an Austrian who trained under Billroth and in 1908 became president of the German Surgical Society, in addition to using an arm flap for the palate, dared in one case to fill a palate cleft with a little finger. In 1901, in a patient with secondary bilateral cleft of the lip and palate deformities including a depressed nose and hard palate defect, he planned a procedure to correct both problems. A ventral skin incision was made the full length of the fifth finger to the metacarpophalangeal articulation, and the skin was dissected and turned back on either side, exposing the ventral surface. The flexor tendons were cut subcutaneously at the base of the finger. Then the little finger was inserted into the mouth and, guided by a suture through the skin of the nose, was used to push up the depressed nasal tip. The denuded surface of the finger was sutured as well as possible to the freshened borders of the premaxilla and septum nasi and the hand fixed with a plaster cast. At 13 days the blood supply to the finger was gradually compressed with a tourniquet, until, after 20 days, the finger was detached from the hand. A secondary procedure was necessary to straighten the flexed finger so that it could be used to fill the palatal cleft.

Quite apart from the nasal and palatal improvement, this approach has near classical overtones. The patient’s position of finger into nose has artistic qualities rivaling Venus de Milo, if only with a little finger instead of an entire arm at stake. It is even possible that this is the origin of the saying “keeping your finger on the problem.” I remember how infatuated Sir Harold Gillies was with the finger-to-palate procedure because of its application of the plastic principle of replacing missing tissue with similar tissue in kind, certainly bone for bone, if only skin for
mucosa. He was not, however, fascinated enough to threaten to sacrifice a little finger. Today this approach is more of historical interest than practical value, I hope.
During the reconstruction of World War I facial injuries, multitudes of pedicle flaps were used, and as the techniques were perfected, the tube pedicle evolved. H. P. Pickerill of New Zealand, stationed at Sidcup with Gillies, claimed that he was the first to introduce a tube pedicle to the palate for traumatic loss. In 1928 he advocated tubed skin pedicles from the neck or abdominal region constructed so to close the traumatic defect with a partition covered on both surfaces with skin.

The next logical sequence of events was to be the use of the tube pedicle in congenital clefts, but this step met bitter opposition. Victor Veau of Paris severely criticized the use of these distant flaps for closure of congenital clefts, referring to such procedures as "surgical crimes" in his 1931 book. Ivy vehemently seconded this stand. Dorrance also was not enthusiastic about the foreign pedicle transfers, and Kilner would turn almost purple at the mention of putting a patient through a series of operations to get a pedicle into the palate. I recall vividly Gillies' invitation to Professor Kilner to come to Rooksdown House to see all his tube pedicles on their way to palate clefts and how the little professor fussed and fumed over the entire situation.

Nonetheless, many surgeons have dared to transfer tube pedicles to cleft palate. In 1917 Hugo Ganzer of Berlin reported a method of closing a traumatic palatal defect by a pedicle flap from the inner hairless surface of the arm. He pointed out that he formed the pedicle of this flap into a cord before introducing it into the mouth. He also fashioned the end of the tube like a lined collar button to plug the palatal perforation, as described by Hoffman-Axthelm of Berlin in his 1975 book on Ganzer.
According to Dorrance, in 1920 W. T. Coughlin implanted a piece of costal cartilage with its perichondrium (40 by 6 mm.) into a tube pedicle of neck skin and platysma which was transferred into the traumatic palate defect successfully in five operations.

QUICK

Balcombe Quick of Melbourne, Australia, according to Sir Benjamin Rank, was to the manor-born, probably receiving the Little Lord Fauntleroy treatment as a child, which left its touch of pomposity. Yet Quick was ingenious in dealing with residual surgical problems in World War I, conceiving the principle of exteriorizing bony cavities of the lower extremity and lining them with split-skin grafts. He was also the first to transport the tube pedicle to a cleft palate patient. In April 1928, he tubed the skin of the neck parallel to the sternocleidomastoid muscle (13.75 by 4.3 cm.). Approximately six weeks later, the upper end of the tube was severed and attached to a triradiate incision in the left inside mucosa of the lower lip. Three weeks later, in a delay procedure, a skin graft inlay was inserted obliquely across the lower end of the tube to create a lined, thinner extremity to join into the velar cleft. After further delays, the flap was detached, incised along its sides and inserted into the freshened edges of the posterior two-thirds of the cleft (A). Since there was difficulty with this attachment, Quick had to disconnect the pedicle and reverse its attachment (B), suturing only one side to the posterior two-thirds of the cleft.

Six months from the time of tube construction, the lip attachment was divided and the freed pedicle let into the posterior palate. Quick reported:

The graft was now in position and the cleft closed in its posterior two thirds. Closure of the anterior one third which had been planned as part of the last stage, had been rendered impossible by reversal of the position of the graft from A to B. It was thought, however, that a dental plate would deal satisfactorily with this deficiency in the hard palate.
The tube was “defatted,” the pillars of the fauces were advanced medially toward the uvula and a denture with an obturator completed the construction.

**PADGETT**

Earl Calvin Padgett was trained by Blair, who considered him the greatest of his scholars. He was also a pioneer and an innovator, conceiving and developing the first dermatome and introducing pharyngeal flaps in the U.S.A., and one of the early surgeons to transport tube pedicles to the palate cleft. Evidently he was always something of a “madcap” scholar, wielding his scalpel with bold sweeping strokes which even today, during recall, cause Kathryn Stephenson to flinch slightly. Once, when a cleft palate had lost a dangerous amount of blood, he stopped operating long enough to roll up his sleeve and give his blood to the patient. It is said that he was fond of “spirits” and after a long day in surgery he would fill up, hop into his two-horse surrey, and race around Kansas City.

As early as 1930, and finally in his bold 1948 book, *Plastic and Reconstructive Surgery*, written with K. L. Stephenson, he advocated the use of distant skin tube pedicles for palate construction. He was never intimidated by the difficulty of the surgical problem or the criticism of such renowned colleagues as Veau and Dorrance who had expressed their abhorrence to tubes in the mouth. He recognized some of the problems of transporting tube pedicles and noted:

In the earliest cases, the mistake was made of tubing the part of the flap which was to be inserted into the mouth. Such a flap was too thick for the best ultimate result, and much more difficult to sew into the palate edges. A flat flap with a skin graft in the opposite surface was easier to sew in place the required width of raw overlap necessary. Up to the mouth the flap should be tubed, so that a flap long enough with a good blood supply is obtained.

In detail, he described tubing the skin of the inside of the arm but lining the upper portion of the flap destined for the palate (a) and the total donor area with a thick-split graft. When the
pedicle was ready for transfer, Padgett carried it directly into the mouth and attached it to the recipient site, which he prepared by turning shelf flaps up from the remnants of the defect and a pharyngeal flap forward to aid in the attachment posteriorly. In some cases, he attached the flap to a flap beneath the upper lip, which then facilitated the transfer of the opposite end into the palate defect. Once when his direct palate attachment from the arm failed, he attached it to the lip as a temporary touchdown.

Padgett relished feats of combining various relatively rare procedures with a posterior pharyngeal flap to aid his posterior palate closure. After a local turnover flap of scar, he brought in an extraoral tube with a skin graft inlay to close and line the anterior palate hole.

His general approach to this procedure was remarkably similar to what Gillies worked out independently many years later.
In 1936, in his explicit little book *Technik und Ergebnisse der Gaumenplastik*, Georg Axhausen of Berlin used the tube pedicle to fill holes in fistulous, scarred secondary cleft palates. He called upon the cervicopectoral region and upper arm for donor areas and used the upper sulcus or columella site as attachment bases prior to introducing the tube into the palate defect.

In one case, he used a tube pedicle to reconstruct the columella as well as close the large palate hole.

In 1947 W. Brandon Macomber of Albany, New York, with William T. Berkeley, presented a group of U.S. Army traumatic
Jean Gustave Ginestet, a short, muscular man with an explosive speech and a quick step, started World War I as a stretcher-bearer and ended up a medical officer gas-poisoned at Verdun. He later earned both dental and medical degrees and during World War

defects of the face in which they used a tube pedicle from the neck for the reconstruction. They noted color, texture and thinness of the tissue, proximity to the defect, vascularity of the neck and ease of donor area closure along natural lines. One of the cases was a severe palatal defect in which the neck pedicle was introduced through the cheek defect in the nasolabial region.

Surgeons who transfer tube pedicles into the palate demonstrate a little more than the usual fortitude. Evidently Macomber’s postwar pedicles to palate only tickled his courage, for in 1961 he received the Allwyn Cooper Award and in 1966 the Weatherby Big Game Trophy.

In 1967 in Nunga he shot a record elephant that served as lion bait. With his white hunter he followed the largest tracks and had just noticed that these tracks turned back on themselves when there was a tremendous roar and rush through the bush. A great maned lion, not in sight until only 10 feet away, was already fully outstretched in the air when both Macomber and the white hunter shot him in the chest. The momentum carried the beast on top of the white hunter, pinning him to the ground. Macomber had time to kneel and fire, but the lion whirled back on him and, in the mauling, crushed his left rib cage. As the white hunter retrieved his rifle, the lion attacked him again, clawing and biting, giving injured Macomber the shot he needed to drop the rogue. Both men ended up in an African hospital in Bulawayo, Southern Rhodesia, and eventually they returned to their chosen specialties.

KOSTRUBALA

In 1950 Joseph Kostrubala of Chicago presented four traumatic losses of the palate in which he closed the defects with tube pedicles taken from the arm or abdomen, carried on the wrist. He introduced each tube through a portal other than the mouth, using the cheek, the side of the nose or the alveolar gap.

GINESTET

Jean Gustave Ginestet, a short, muscular man with an explosive speech and a quick step, started World War I as a stretcher-bearer and ended up a medical officer gas-poisoned at Verdun. He later earned both dental and medical degrees and during World War
II served as chief of maxillofacial surgery at the hospitals of Val de Grâce in Lyon and Foch in Paris, being given the rank of general in the Army Medical Corps. He was the first French surgeon to use tube pedicles, and one of his 520 papers was devoted to transplantation of arm tube pedicles to cleft palates. In his 1952 report he used the tip of the nose as a pedicle attachment on the way to the palate and left enough pedicle behind to construct the short columella. In 1967 L. Merville, a student of Ginestet, published a case of brachial tube pedicle used to close a large cleft of the palate in the manner of Ginestet.

**GILLIES**

There is no question that the personality of the surgeon influences his approach. Braithwaite noted in his comparison of McIndoe and Gillies:

Archie wanted to get on with the job and, I believe, used free skin-grafts because of the speed of accomplishment they afforded. Sir Harold used “tube pedicles,” not only because of the skill with which he designed and used them, but also because of the arguments he could provoke amongst his acolytes. The twinkle in his eyes denied the possibility of malicious pleasure in the discomfiture of his victim. Archie always said that a person plastered with a pedicle on his face could smile behind it and betray no feelings. Sir Harold’s retort was that a free-graft treatment of a face turned the recipient’s face into a variegated piece of immobile linoleum.

The same criticism might be directed to tubes to the palate as their bulk and weight could in some instances cloak or choke speech.

It is interesting that it took Gillies, one of the originators of the tube pedicle, so long to come to putting tubes in the palate.
Once he got started, his enthusiasm was unbounded. He estimated that at two and a half pedicles per week he and his assistants had constructed enough tubes (like sausages laid end to end) to string the Royal Mile from Buckingham Palace down the Mall through the Admiralty Arch to Trafalgar Square and halfway up Nelson’s monument. He admitted in 1953, published 1957:

It is my ambition that before my last pedicle is made, we will reach the top of this famous pinnacle with at least one pedicle left to go into the admiral’s palate.

It is likely he made it, but as he said:

It is not a little embarrassing that Brophy suggested many years ago that I should put tube pedicles into palates. Indeed, in Plastic Surgery of the Face, 1920 (page 208), it is categorically stated that tube pedicles were inserted for traumatic losses of the palate and the method was considered normal. Pickerill, in 1928, was the first to report putting a tube into a traumatic palate defect, but it was Balcombe Quick who in 1929 first applied the principle to the congenital defect and with startling success. Today a timid murmur of approval may be heard—Bunnell, Pickerill, Schuchardt, Padgett, Kitlowski, Claoué, Ginestet and Leboug. At Rooksdown a combination of maxillary osteotomy and a tube pedicle replacement is now routine advice in many old cleft palate cases.

In 1953 Gillies proposed:

The palate may sometimes end up too short and too tight. Such a velum can be relaxed only by pushing it back and letting a pedicle into the defect. . . . Or go further and split the still tight soft palate, interposing the pedicle between the two halves; or even further and continue it all the way back to the pharynx, attaching it there.

When this technique was suggested, Balcombe Quick’s comment was:

Which does, in fact, out-Wardill Wardill.

Encouraged by this reaction, Gillies attacked the bogey of the intact muscular ring, admitting:

There are many surgeons who will throw up their hands in despair at the thought of introducing a non-muscular tube pedicle into a constricting muscular ring. . . . In any ordinary soft palate suture giving good speech
there must of necessity be a scar between the two halves of the joined palate... Why should that scar not be broader, and if so, what better broad scar and what better median raphe have you than to interpolate a tube pedicle between the muscles? Attach it to the pharynx and you have a fixed raphe—a handrail from which these indifferent palate muscle halves can take purchase when closing their [now two] little sphincters.

In fact, Gillies developed a staged procedure which in 1967 Merville presented with excellent diagrams showing the end of the tube attached to a trapdoor posterior pharyngeal flap and one of its sides incised and sutured along a freshened side of the palate cleft (a). As soon as an adequate blood supply had been established, the pedicle was divided and set into the anterior defect (b). Later the opposite side of the tube was joined to the other side of the cleft with complete closure (c).

In *The Principles and Art of Plastic Surgery*, completed by Gillies and me in 1953, various possible interim attachments were noted, such as the lip, through a nasolabial incision as described by Schuchardt, or back of the masseter as advocated by Kitlowski.

As for the midline submental route to the palate, which would no doubt avoid accidental biting of the pedicle, we warned:

No, don't! This approach was not found practical because, although the method short-circuits the teeth, the unruly tongue pushes the pedicle off the palate.

One obvious group of tube pedicle candidates were all Gillies-Fry palate patients who had been condemned to wear a huge obturator requiring constant dental supervision, irritating the nose and lodging food. As Gillies and I wrote:
Graft in a tube and throw away the obturator so that the patient can be sick on a cross-Channel voyage and still enjoy a happy landing, eat and speak normally and kiss or be kissed without fear of being found out.

Here is an attractive young girl with lovely teeth who, because of an early Gillies-Fry palate operation, had been forced to wear an obturator. Persistent stomatitis necessitated removal of the obturator, so John Barron, then at Rooksdoun House with Gillies, undertook the task of filling her anterior palatal hole (arrow) with a tube pedicle, much to the relief of the patient.

This method worked well in secondary correction in adults. The pedicle was introduced through the mouth or through the nasolabial incision. Joyce was one patient so treated. She had had nine operations for a severe bilateral cleft lip and palate, but she still had a cleft and, in addition, a nasal deformity, a short, tight lip and a contracted maxilla. The lip was opened, the nose was released and a maxillary osteotomy spread the bony cleft wider. Then a pedicle tubed on her arm was passed through her mouth so that its end could be attached to a turnback pharyngeal flap. The posterior edges of the tube were incised and sutured to the freshened edges of the velum in an attempt to speed up blood supply to the pedicle.
Finally, the pedicle was divided from the arm and used to close the anterior palate cleft and assist in construction of the lip and columella base. This indeed achieved an excellent closure of a severe cleft.

Joyce was chosen by Richard Dimbleby to give a radio interview on his “Down Your Way” program. We all crouched with Gillies about the radio, frightened at the thought of what noises might come forth. After she had overcome her preliminary nervousness she spoke very well.

Tube pedicle to plug fistula
A fistula can be plugged with a tube pedicle if there happens to be one in the vicinity. As Gillies and I wrote in our book:

The surplus end of the pedicle, lying there like a closed-off sausage, was freshened by taking off a cuff but leaving the skin dome on the top. A silk thread was drawn through the antral fistula via the nose and attached to the summit of the sausage; the pedicle was then pulled through to plug the fistula, raw surface to raw surface. This sealed off the antral cavity with the little dome of skin.

After a few trying but successful insertions of tube pedicles into secondary palates, Gillies began to consider the method for primary cases. Even in the best hands, only 80 percent of the primary palate operations resulted in normal or near normal speech. He challenged:
This leads to the supreme question. Can we, in that "other 20 percent," avoid alveolar distortion, attain good speech and have no call for an obturator? The answer lies in the introduction of new tissue, certainly, in the form of a tube pedicle, possibly—at the primary intervention. Or is this swinging the pendulum too far?

A little too far!

Not all candidates, even willing ones, are suitable. This Rooks-down patient is an example, as noted in our 1957 report:

A letter was received from a man with a cleft palate who explained he was not in favour of a Wardill, a von Langenbeck, a Gillies-Fry or even a Dorrance push-back—he wanted a tube pedicle! Naturally we were impressed, for this was indeed a new twist—usually the swallowing of a tube pedicle takes a lot of talking. An appointment was given, and the young accountant came in and convincingly repeated his desire. As his cleft palate was a suitable one for a pedicle, hospital admission was arranged, and while the iron was hot a lovely tube was made on his abdomen. Whereupon the patient went crazy and the next thing we knew he had admitted himself to the Park Prewett Mental Hospital next door. As he was a voluntary patient he soon became bored, signed out and caught the old red double-decker bus for the Basingstoke railway station. The last we heard of him was from one of our patients, who happened to be riding on the same bus. It seems our palate boy was passing from passenger to passenger inquirin if anyone knew how to get rid of a tube pedicle.

A primary case

Little Kay had a wide cleft in a short palate. A much debated and rehearsed plan to implant the tube pedicle and suture the little halves of the palate to it finally emerged. The fat pedicle not only had an indifferent blood supply but was too big for the mouth, so that suturing was unseen and probably incomplete. As we recorded in our book:

Kay was as sweet as pie, took fluids, never cried, and waved her doll at visitors. On the seventh postoperative day it was noticed that the pedicle had moved slightly out of her mouth. The pixy’s little tongue had quietly pushed the pedicle off her palate. Is this a failure or a blessing in disguise, or will it merely serve as a challenge?

In 1954, while chief plastic surgeon to the First Marine Division in Korea, I was stimulated to take up Gillies’ challenge by
Kim Moo Uy, a 10-year-old Korean boy with a wide unoperated bilateral cleft of the lip and palate. Previous treatment by an oral surgeon had cost him his premaxilla. In addition, he revealed moderate maxillary underdevelopment. An abdominal tube pedicle was “pocketed” on the wrist and later attached to the prolabium. At this point there was a change of command and a new policy that abolished elective (?) surgery on the natives. The pedicle was detached from the wrist but left dangling at the time of discharge, as I had no intention of scrapping this pedicle, orders or not.

During the interval of his discharge Kim returned to his native village. Before his entrance into the American Hospital, he had had only a bilateral cleft lip, but now a great elephant trunk dangled from his nose. There was a noticeable slackening of native patients attending our outpatient clinic.
When a local Korean hospital became available, signs were placed for all our wandering patients. Kim found his way to Kum Chon where a pushback of the palate was followed by introduction of the tube pedicle into the anterior defect. Later the distal end was used to create an anterior alveolus-like ridge. The prolabium was shifted into the columella and an Abbe flap used to construct the philtrum of his upper lip. Once his surgery had been completed, the patient flow started up again. On Christmas that year, for being a perfect and patient patient, Kim was presented a candy tree sent by Barbara Smith all the way from Tulsa, Oklahoma.

**More tubes**

At the First International Congress of Plastic Surgeons, held in Stockholm in 1955, there were numerous papers on introducing tube pedicles into clefts of the palate. Sir Harold Gillies and A. J. Evans of Basingstoke, England, displayed a grand group, and, with special permission from honorary committee member Mario Gonzales-Ulloa, I showed little Kim of Korea in an unscheduled presentation. There were two more official papers.

**Č U P A R**

Possibly as a by-product of Gillies' personal meeting with Marshal Tito and his close teaching experience with the Yugoslavian plastic surgeons, the tube pedicle had become popular in this
picturesque Dalmatian coast country. Ivo Ćupar of the University of Zagreb, desirous of avoiding weeks of the uncomfortable arm-to-head attachment with the ridiculous open mouth position, advocated two possibilities. The cervicopectoral skin tube was his first choice as it could be made long enough for direct transfer into the mouth, while the acromiopectoral tube, also available, required its first attachment in the neck. Ćupar recommended an incision below the lower border of the mandible. At this point the entrance could take one of two routes. If the defect of the palate included the alveolar ridge, the flap should be introduced on the buccal side of the mandible via the vestibule (A).

If the defect was in the middle of the palate with existing teeth, entrance should be made through the floor of the mouth on the lingual side of the mandible to the palate (B).
ASCHAN

At the same 1955 Stockholm Congress, P. E. Aschan of Helsinki, Finland, presented five cases in which he had used a tube pedicle from the arm first attached into the nasolabial fold of the cheek. In three of the cases, he split either the lip or the cheek to shorten the distance for his pedicle to reach the palate. He used the pedicle not only for the cleft in the soft and hard palate but also to assist in alveolar, lip and nasal construction. He warned:

The pedicle should preferably not be thicker than an ordinary little-finger or the work within the oral cavity becomes technically too difficult. . . .

For the compression and fixation of the unfolded oral end of the pedicle I have used a palate-plate.

Here are two case examples.

REID

Red-haired Douglas A. Campbell Reid of Sheffield, England, trained with Gillies at Rookdown House for a time when numerous pedicles were being transferred to the palate. In 1962 he presented five cases of large palate holes (over 2 cm.) which he closed with tube pedicles in three patients aged 7, 10 and 15 years. He used the inner hairless area of the upper arm for formation of the tube pedicle, which in its next stage was attached to the mucosal flap inside the lower lip near the commissure. At the time of final division of the pedicle from the arm and on its way to the palatal defect, Reid slyly slipped an acrylic sleeve like a napkin ring over the pedicle to protect it from the teeth’s temptation to bite the “sausage.” This was a safety ma-
neuer to make the direct oral entrance for pedicles more palatable.

SC U C H A R D T

At his Second Hamburg Symposium in 1964, Karl Schuchardt presented his use of a tube pedicle to a wide cleft of the hard and soft palate in a 25-year-old patient who had had two unsuccessful procedures in childhood. He filled the parapharyngeal pouches with dovetailed adipose tissue of the end of the tube pedicle denuded of skin. The final result is shown with the soft palate at the height of phonation.

N E U N E R

In 1971 Otto Neuner of the University of Berne Dental School described use of a cervicoacromial tube flap which he literally
threw over the shoulder and slid into an incision under the earlobe to pass through a tunnel medial and posterior to the ascending ramus of the mandible. Its distal end was attached to the palatal defect, and after three weeks the neck attachment was divided and spread to fill the remaining tissue deficiency. Neuner noted:

In the fourth operation, one can nicely form the palatal arch with the abundance of material present. As many cleft palate patients exhibit shortening of the velum, the velum can be lengthened posteriorly, thereby improving speech potential.

This posterior entrance calls for clever anatomical tunneling and avoids the disturbance of masticatory function or encroachment upon speech during the three weeks. It might be argued, however, that reduction in temporary discomfort does not warrant the back and neck scars or the close, blind skirting of the facial nerve.

**Almost Extinct**

With the modern approach to cleft palate, the need to bring in a tube pedicle monster should be almost nonexistent. It is, nevertheless, a procedure that is available in case of a rare palatal catastrophe.
51. Flaps and Free Grafts of Distant Muscle, Tendon and Fascia

In the heroic attempt to impart some extra dynamic action to the velopharyngeal sphincter, various extrapalatal muscle, tendon and fascia flaps and free grafts have been used. Although the dynamic action has been questionable in most cases, each method deserves consideration.

LATERAL MUSCLE TRANSPOSITION

Imaginative Otto Neuner of Berne has developed a procedure he calls "levatorplasty." He claims to improve the levator function by dissecting out the medial pterygoid muscle on each side and transposing them in a crisscross, so that they embrace arm in arm in the body of the velum.

This operation was performed by Neuner in 8 cases with excellent results as regards to consonants and satisfactory ones as regards to vowels.
LATERAL TONGUE FLAPS

Neuner has also designed a use for the tongue in velopharyngeal incompetence. He entitled this procedure "arcus palatoglossus-plasty." It attempts to thicken the anterior tonsillar pillars and increase the mobility of the arch by inserting "a pedicle musculomucosal flap" from the lateral margins of the tongue. Neuner reported this operation, always in two procedures, was performed in 8 cases with speech improvement to normal phonation. This lateral partial glossectomy contributed to these end results, most of the patients suffering from a certain degree of compensatory macroglossia.

TEMPORALIS MUSCLE AND FASCIA

Clifford L. Kiehn, plastic and maxillofacial surgeon and an important leader of American plastic surgery, in 1965 with J. DesPrez, A. Tucker and M. Malone of Western Reserve University, Cleveland, Ohio, presented a study of 19 patients aged 6 to 16 years, in whom muscles supplied by the fifth cranial nerve (temporalis in 17 and masseter in 2) had been transplanted into the soft palate through use of an intervening fascia lata graft from the thigh. They reasoned:
If the palate could be elevated to the superior position to diminish the nasopharyngeal space without interfering with normal physiologic function of this area and if some dynamic mobility could be added to complement or replace the static function of the nasopharyngeal flap, this would constitute a most desirable surgical procedure.

They noted no deterioration in speech function following the procedure and reported:

In four cases, improvement was negligible or extremely slight immediately after operation. In 15 patients, there was definite improvement which was encouraging or satisfactory, according to our clinical impressions and the opinions of family, friends and teachers. It appears to us that the best results so far have been obtained in patients with paralyzed palates or without true clefts (*forme fruste*).

By 1971 Kiehn, DesPrez, Maes and Kronheim had modified their method by peeling the superficial fascia upward and leaving it attached to a strap of temporalis muscle based inferiorly, to create a long component as described by Gillies for lagophthalmos. They created the musculofascial components bilaterally and threaded them under the arch of the zygomas, medially through the soft palate to the median raphe, and sutured them to each other. In 50 cases, they reported, these temporal transfers had improved naso-pharyngeal valving, preventing more air from escaping through the nose during utterance of sounds and words.
Cliff Kiehn wrote in 1976:

I believe many of our cleft palate failures after closure are not due entirely to the surgical technique, but to a hypoplasia of musculature. This is particularly true in the adult unoperated cleft palate where the soft palate is not developed because of lack of normal positioning and the atrophy of disuse. Biopsies of these palates show deficient muscular structure. This gave me the idea to find a nearby muscle supplied by a different nerve to add to the dynamics of the palate. I chose the temporalis muscle because of its success in facial paralysis by Gillies. Originally, I took the temporalis muscle off the coronoid process, and put the fascia from the thigh in the soft palate and hooked it up to the temporal muscle on each side. It seemed to work very well. . . . Then as time went on, I used the temporal muscle and fascia, as used in 7th nerve palsy, and threaded them into the soft palate. It is important to use as large a muscle as you can get under the zygomatic arch, and the shorter the fascial attachment, the better. It is practically impossible to get muscle to muscle in the midline of the soft palate because of its width. Of course, it does not produce ideal speech in every case but I think that it can be a valuable adjunct. . . . I have found this surgical procedure very helpful in people with cleft palate speech without cleft palate, following removal of tonsils and adenoids. There is not one of them who has not been improved in their speech.

Finally, never underestimate the power of gravity. That is why I believe in dynamic and static slings in facial paralysis and this same principle can also be applied to cleft palate surgery. Back in the fifties, Emlyn Lewis of Wales joined Pete Moran on a panel, with each giving papers on muscle-fascial slings in facial nerve palsy. Lewis, as guest, went first and showed excellent slides of results of closure of the eyelids and function of the corner of the mouth. Then Moran rose and gave his paper on the same subject and his results were even better. As a matter of fact they were practically perfect. After the discussion Moran confessed to the audience that his slides had been made with his patients standing on their heads with gravity working, as well as the dynamics of the muscles. This, of course, brought the house down. I have also noticed that if you stand your cleft palate patients on their heads they will talk better, and I have done this with my little kids many times.

THOMPSON

Noel Thompson of Middlesex Hospital, England, since 1968 has carried out extensive work in free autogenous muscle grafts and in 1971 published his principles, reiterated in 1974:

(1) the muscle graft must be transplanted as a complete muscle belly to
preserve the entire length of its constituent fibres; (2) it must be denervated 2 weeks before transfer; and (3) it must be applied at the recipient site to normal striated muscle from which reinnervation of the graft can occur.

He presented his use of this concept in the treatment of velopharyngeal incompetence with speech specialist Lesley Mathieson at the International Congress on Cleft Palate held in Copenhagen in 1973. It was published in *Clinics of Plastic Surgery* in 1974.

The theory of a velopharyngeal purse-string as an aid to speech was first presented by Denis Browne of London using a strong chromic catgut suture. Thompson chose as his purse-string a

musculotendinous complex from the foot. The four muscle bellies of the extensor digitorum brevis muscles of the foot were taken and sutured together to provide a leading and a trailing tendon, between which a bridging segment of surplus tendon was sutured to protect graft muscle fibers from traction stress. Then, through a 5 cm. external cervical incision parallel to the anterior border of the sternocleidomastoid muscle, the posterior belly of the digastric was elevated so that dissection could be made behind the hypoglossal nerve across the lateral pharyngeal space to create a roomy pocket above the superior constrictor muscle, at a level behind the upper border of the anterior arch of the atlas. The soft palate was split, and an incision in the posterior pharyngeal wall allowed pullout of the tendon and threading of both tendon ends around the lateral pharynx and through the soft palate to be tied together in the middle.
This was the 1974 claim on seven cases followed for periods of nine months to three years:

While improvement in speech was present at all stages, contractile function only became visible in the graft after about 6 months, and speech improved up to 1 to 1½ years postoperatively. . . . Lateral Pharyngeal [vocal] Cineradiography . . . demonstrated improved velopharyngeal closure with sphincteric competency (broad closure in four patients, touch closure in three patients) being obtained in all cases treated.

BROMBERG AND SONG

Some years ago it occurred to Bertram E. Bromberg of Long Island, New York, to use the palmaris tendon to encircle the pharynx. By attaching the tendon to the anterior belly of the digastric in the region of the hyoid bilaterally, he hoped to get both a dynamic and a static force. During speech, with the mouth opening and closing, the tendon would be stretched and would thus constrict the pharynx with a dynamic action from the anterior digastric. Bromberg recalled in 1976:

Unfortunately, the placement was unphysiological and the direction of pull too low. It was only after Thompson’s work that we went back to palmaris longus muscle for use in a pharyngo-palatoplasty.

In 1974 in the *British Journal of Plastic Surgery*, Chul Song and Bertram E. Bromberg described the use of the palmaris longus muscle of the arm as the purse-string for velopharyngeal incompetence. They carried the procedure out in conjunction with a three-flap Wardill pushback palate closure in three cases.
The muscle belly was introduced in a pocket behind the posterior pharyngeal wall, and the tendon extensions were brought around and inserted into the contralateral levator musculature to act as a type of purse string.

Their discussions and conclusions are of interest:

This [type of muscle transplant pharyngo-palatoplasty] offers three distinct advantages:

The soft palate lengthening gained by the pushback procedure is maintained by the tendinous traction provided by the transplant. [Thus permanent sufficient length of velum to effectively function as a flap valve mechanism is provided.]

Augmentation of the posterior pharyngeal wall results in permanent narrowing of the velopharyngeal space. . . . In Thompson's (1971) description, only denervation precedes transplantation and re-innervation is generally anticipated. We found it extremely difficult to obtain pure denervation and it would appear that devascularisation is a frequent accompaniment. Even if survival of the entire muscle does not occur, the bulk effect is not lost, because of fibrous tissue replacement although the chances of dynamic function are obviously reduced. Electromyographic studies 6 months and 1 year after muscle transplantation did not reveal any active action potentials.

A correct anatomical and physiological type of reconstruction is created and should provide the same form of movement as in the uncleft individual, particularly if re-innervation is indeed possible; if it is not, at least bulk is obtained in the area of Passavant's ridge and by means of the functioning levator and superior pharyngeal constrictors a good anteromedial motion of the pharyngeal walls provides a satisfactory purse string effect.
52. Implantation of Material into the Retropharyngeal Space

Paraffin

In 1900 Gersuny suggested the possibility of advancing the posterior pharyngeal wall to secure velopharyngeal closure by injecting soft paraffin into the retropharyngeal space. In 1904 Eckstein modified the method by substituting hard paraffin. The ill effects of paraffin injection into the retropharyngeal area with the possibility of migration and even mediastinitis were eventually pointed out by Lexer, Warnekros, Roese and von Gaza.

Autogenous Cartilage

In 1912 Hollweg and Perthes first suggested insertion of autogenous cartilage into the posterior pharyngeal space by an external cervical approach. In 1928 Wardill, in his typically direct manner, suggested the transoral route for the introduction of autogenous cartilage. By 1947 Bentley had demonstrated poor long-term results with this approach.

Fat and Fascia

In 1925 H. Halle used fascia for the retropharyngeal implant. In 1926 von Gaza introduced fat and fascia from the abdominal and gluteal region of adults and fascia lata in children, behind the posterior pharyngeal wall, to produce bulging. His fear of infection caused him to avoid the intraoral approach and to make the
insertion through the neck by way of the superior triangle. Dorrance recoiled from this approach, citing the skill required, the danger involved, and the free graft shrinkage inevitable as the child's pharyngeal canal increased in size. He concluded, in a characteristic, dogmatic offense, that the maneuver was not justified when there was such "a simple procedure as the 'push-back operation'" available.

HOMOLOGOUS CARTILAGE

In 1950 Russian Lando used cadaver cartilage for his posterior pharyngeal implant.

Robert Hagerty, a Bostonian entranced by the charm and warmth of old Charleston, works at Ashley House, lives in a nearby renovated slave quarters and has greenhouses within Confederate cannon range of Fort Sumter. He worked out a wick-in-trough watering method for his three greenhouses of geranium pots with the same concern for basic principles and careful technique that he studied cartilage and its use in pharyngoplasty. Following excellent studies on pharyngeal wall and palatal movement in normal and cleft palate patients, Hagerty pioneered augmentation pharyngoplasty in the United States. In 1960, in a continued serial in Surgery, Gynecology and Obstetrics, Hagerty, Calhoun, Lee and Cuttino studied human cartilage preserved in air, merthiolate and plasma. In 1961 Hagerty and Hill presented their cartilage pharyngoplasty, which placed the implant just above the atlas promontory (first cervical vertebra) at the level of greatest potential velar impact. This was accomplished through a 2 cm. transverse incision using homologous cartilage stored in air at 3° to 5°C. The implant was buried deeply under the muscle on the prevertebral fascia and the wound closed with chromic catgut sutures. In his straightforward manner, Hagerty, with Mylin and Hess, in 1969 reviewed 40 out of 64 cases of augmentation pharyngoplasty, concluding that this procedure appears to have something to offer the patient with good palatal mobility but inadequate velopharyngeal closure. With the use of homologous cartilage as the augmenting material, one can expect gradual absorption—
with possible decrease in the anterior projection of the posterior pharyngeal wall by as much as two to three percent per year.

In spite of gradual cartilage absorption and tonsil involution, Hagerty feels that increased palatal mobility compensates adequately for the eventual loss of pharyngeal wall projection, with improved speech as a long-term result. In 1971 he told me that the difficulty of maintaining a cartilage bank has influenced him to use silicone for his more recent pharyngoplasties, and he admits an occasional extrusion of the implant. At 6 years of age, if speech and cinefluorography of the soft palate indicate a need for a secondary pharyngoplasty, it is performed through a transverse incision over the atlas promontory. A soft block of Silastic is shaped \( \frac{3}{2} \times \frac{1}{2} \) and 1 cm. thick and inserted into a pocket created with curved scissors. The wound is closed with vertical mattress sutures.

While at Pawley's Island, South Carolina, in the summer of 1976, I called on Hagerty to get his latest stand on posterior pharyngeal wall implants. After the speech pathologist's evaluation and if the soft palate motion is good with no more than 1 cm. distance to the posterior pharyngeal wall, he will do an implant. The patient must be 5, 6 or 7 years old, no younger. A piece of fine silicone is fashioned at the operating table, and holes are made in it to aid in fixation by fibrous tissue invasion.

**SILICONE**

Ralph Blocksmoa of Grand Rapids, Michigan, in 1963 suggested silicone implants for augmentation pharyngoplasty. In 1968 Blocksmoa and Braly did a world mail survey of plastic surgeons known to be interested in pharyngoplasty. Forty-seven surgeons out of 378 responding reported 372 retropharyngeal implants, including all types of medical silicones, ivalon, etheron, polyethylene, Teflon, autogenous and homologous cartilage, bone and dermaf. Out of 262 surgeons who perform surgery for velo-pharyngeal incompetence, 50 percent approved of the implant principle, 35 percent disapproved and 15 percent were undecided. Regardless of the material implanted, speech results in general were far better than tissue tolerance scores. Speech results were best
when the incompetence gap did not exceed 5 mm. on preoperative cinefluoroscopic examination.

In 1971 Blocksma concluded after a study of his 38 retropharyngeal silicone implants that, in general, medical silicones have shown a very high rejection rate with the possible exception of RVT Silastic S-5392 liquid, which vulcanizes into a gel in vivo after a catalyst is added prior to injection. However, like Dow Corning medical fluid MDX-44011, it is still banned from use by the Food and Drug Administration. Blocksma felt that experimentation with silicone fluids and Teflon paste held promise because of the simplicity of the injection but that it was too soon for evaluation with regard to speech improvement and tissue tolerance. Having become known for his interest in silicone work, he concluded, with his usual honesty:

The safest material at present for retropharyngeal implantation is homologous cartilage in young children in whom the palate is moveable and the deficit small.

Thus, for a time, Blocksma joined Hagerty in the use of cartilage but then, like Hagerty, switched to silicone. Yet by 1975 Blocksma was back with the paste:

In cases with minimal velopharyngeal incompetence (as shown by panendoscopic examination), we have injected PTFE paste [Ethicon] behind the posterior pharyngeal wall with a Lewy syringe, as an outpatient procedure. An average of two to 6 cc is implanted, depending on the preoperative panendoscopic findings.

**TEFLON**

Teflon injection of the paralyzed vocal cord has been studied since the early 60’s. In 1962 G. E. Arnold and in 1963 R. B. Lewy reported dramatic restoration of vocal function by the injection of the paste into the paralyzed vocal cord. In 1964 Lewy injected Teflon into the posterior pharyngeal wall of one patient with neurogenic velopharyngeal incompetence and obtained improved speech. In 1966 Lewy reported an intracordal Teflon injection; the case went to postmortem for unrelated disease and revealed only fibrosing foreign body reaction to the Teflon.
Lewy, Cole and Wepman promoted posterior pharyngeal Teflon injection in 1965 for velopharyngeal incompetence. They used a 50% suspension of polytetrafluoroethylene in glycerine (Ethicon PTFE) with the consistency of toothpaste, which was injected through a 17-gauge needle on a special pressurized Lewy syringe. Ward and Wepman confined the injection of the Teflon paste to the submucosa and superior constrictor muscle, forming a ridge across the posterior pharynx using 4 to 30 ml. per injection with a maximal total amount of 98 ml. per ridge.

At the 1967 International Congress in Rome, Charles Bluestone, R. Musgrave and B. J. McWilliams of the University of Pittsburgh reported that since 1964, 27 patients between ages 5 and 82, who revealed hypernasal speech, good levator activity and near velopharyngeal closure (3 mm. gap), had been submitted to Teflon injection pharyngoplasty. Under general anesthesia with a Jennings mouth gag aided by a Love palate retractor, the patient received 10 to 20 ml. of Teflon paste via a Lewy syringe and No. 18 needle submucosally, just above the tubercle of the atlas on either side of the median raphe. The amount was determined by the specific patient need. Of the 27, 16 revealed absence of hypernasality, 11 had improvement, and 5 of these after a second injection were successful, with one failure. The conclusion:

Teflon is an excellent implant material for the correction of velopharyngeal insufficiency in selected cases. It is doubtful whether this procedure is beneficial in patients with poor levator function or a large velopharyngeal gap.

In 1971 James Calnan of London, in an effort to avoid his usual autogenous costal cartilage operation and obtain an implant for treatment of nasal escape following removal of tonsils and adenoids, used Teflon implants cut to size in four patients. In every instance the material was extruded after months with a well-healed pharyngeal wound. He reported that solid plastic implants suffered the same fate.

Howard S. Sturim of Brown University, Providence, Rhode Island, who likes to sail his Pearson 36 along the East Coast, was attracted to plastic surgery by Robert McCormack and to cleft surgery by Ross Musgrave. In 1972 Sturim and C. T. Jacob, Jr.,
reported in *Plastic and Reconstructive Surgery* on 23 patients with velopharyngeal insufficiency treated by Teflon injection pharyngoplasty from 1968 to 1970. Patients selected were those with cineradiographs demonstrating a gap less than 1 cm. between the soft palate and posterior pharyngeal wall during attempted vowel closure, regardless of levator activity or intelligence level. Sturim and Jacob used a Lewy syringe with a No. 18 needle and had good results with 12 patients, improved results with 10, and no change with one. They also made an interesting suggestion:

[The procedure] can be used, also, as a supplemental treatment in patients in whom an unsuccessful pharyngeal flap has been performed.

At the Montefiore Hospital cleft palate center, a super team approach is used in Teflon pharyngoplasty for velopharyngeal insufficiencies no greater than 4 mm. in diameter. Preoperative diagnosis with multiview videofluoroscopy (lateral, frontal, base, and left and right oblique) and flexible fiberoptic nasopharyngoscopy defines the exact location and size of the velopharyngeal gap. On a part-day admission under local anesthesia (sedation and topical 3% cocaine) the patient, as young as 7 years, is placed in supine position. Otolaryngologist Charles Croft, at Pigott’s personal suggestion, introduces a nasopharyngoscope and confirms the gap site marked by surgeon Avron Daniller with methylene blue. The needle is inserted submucosally in the chosen spot and Teflon injected (3 to 7 ml. with maximum 8 to 9 ml.), as seen through the nasopharyngoscope and recorded by speech pathologist Robert Shprintzen during the patient’s phonation. An extra 1 ml. is added for good measure. For small central gaps in the velopharyngeal sphincter, the Teflon is injected in the posterior pharyngeal wall. In the presence of an active Passavant’s pad or adenoid mass in position of valving, this procedure is not used. For a unilateral deficiency, unilateral injection is made, and for an insufficient pharyngeal flap, Teflon is injected into the actual flap.

Postinjectional complications have been minimal but include slight temperature rise, localized pharyngitis, sore throat (one week), stiff neck (one week) and localized edema. In 1977, 20 patients with follow-up of five months to two years, with nasopharyngoscopic examination every three months, were reported as...
revealing no significant shift of Teflon from the injection site, only rare diffusion and no speech relapses (once hypernasality eliminated, normal speech maintained).

Daniller, originally of South Africa, was brought to Stanford University by Robert Chase. In 1977 he wrote from Montefiore Hospital, New York:

The technique of combining the injection of Teflon with simultaneous observation through the flexible Fiber-optic nasopharyngoscope for its precise placement has proven to be most rewarding. I have to issue a word of caution, however, in that the FDA has not fully released this drug, and it is still listed as investigational.

In 1977 Leonard Furlow, W. Williams, K. Bzoch and C. Eisenbach of the University of Florida, Gainesville, reported retropharyngeal injection of Teflon paste in 36 cases (28 with operated or short palates showing mobility and a gap no more than 8 mm, and 8 with nasal emission long after a pharyngeal flap). The success rate claimed was 74 percent in the operated or short palates and 63 percent in the failed pharyngeal flap group. Most cases were corrected by one injection, a few by two injections and none by three. Several patients not improved immediately after the injection improved later, but all who revealed immediate success maintained it. One bolus was extruded. Serial cine speech studies allowed measurement of the posterior pharyngeal wall advancement and the permanence of the Teflon pad with an injection projection of 6.2 mm. lasting as long as seven years.

VACILLATION BETWEEN CARTILAGE, TEFOLON AND SILICONE

In 1971 the clever José C. Viñas with E. Jager of the University of Buenos Aires, Argentina, at the Melbourne International Congress reviewed his development of what he termed "pharyngeal push-forward," an analogy to Dorrance's "Palatal push-back." He first reported having used autogenous costal cartilage inserted through a transverse incision into the retropharyngeal space in 1954. The incomplete dehiscence and partial loss of the
graft stimulated Viñas to try two vertical lateral incisions and
experiment with fresh and boiled maternal and homologous
cartilage, preserved homologous bone, derma-fat grafts and
spongy and compact silicone. Although his life ended tragically
in a train wreck long before his time, he published 13 papers on
various aspects of this subject. All homologous grafts, he found,
were eventually unsuccessful, the autogenous derma-fat ones were
failures, spongy silicone shrank and the compact type extruded.
The last four years he returned to his original choice, made 16
years before, of autogenous costal cartilage, having decided it was
not the cartilage but the poor blood supply of the retropharyngeal
space that was responsible for the difficulties. He described
his final plan and began by splitting the velum for exposure:

A mid-line vertical 4 cm. incision is made in the posterior pharyngeal wall,
using the tubercle of the atlas as reference.

Dissection proceeds laterally exposing the aponeurotic layer, which is
excised over the graft bed required, and thus the muscle layer is exposed.
The space is deepened towards both sides so as to reach the lateral angles of
the pharynx... The piece or pieces of cartilage necessary... are put in
transversally, trying to cover the whole width of the pharynx.

He reported advancement up to 1½ cm. and for periods up to
15 years, and concluded:

Some years ago we left off using pharyngeal flaps. We believe they have been
excessively used. Perhaps some day the last ten years will be remembered as
"The Flapping Sixties"! In the great majority of cases they give no better
results than those obtained with the technique or association of techniques
referred to in this paper.

In 1973 Raymond O. Brauer of Houston, the home of two
famous domes, the Astrodome and the Cronin Silastic breast
implant, reported the use of a lesser dome in the form of a
"pillow" in the retropharyngeal area in 26 patients. This implant,
a Dow Corning Silastic bag slightly underfilled with Silastic gel
and covered with Dacron wool, was made in two sizes—a large
one (1.5 × 2 × 0.6 cm.) and a small one (1.5 × 1 × 0.6 cm.).
Through a 1½ inch lateral longitudinal incision where one
incision of a pharyngeal flap is usually made, he dissected
the muscle from the prevertebral fascia, cutting fibers necessary to
create a pocket toward the base of the skull. Into this pocket one or two "pillows" were implanted transversely, and the incision was closed in two layers.

In 1977 Brauer reported that since 1968 he has used the "pillow" in 38 patients, with five requiring removal because of exposure. Of 28 followed, 11 developed normal speech and 2 almost normal speech, 1 achieved closure, 10 were greatly improved, 3 improved, and 1 did not improve. He now uses an easier midline longitudinal incision, administers preoperative penicillin and has the implant in four sizes (the largest 25 X 14 X 7 mm.). He stated:

This operation has its greatest place in the patient who has a little nasality and where the cine studies reveal excellent soft palate motion with a gap of probably no more than 5-6 millimeters. By moving the pharyngeal wall forward, this patient can achieve complete relief from his nasality. The operation has no place in the palate that is short and stiff or one that is paralyzed. I think there are too many surgeons doing pharyngeal flaps for a minimal defect or doing nothing when this procedure could give the needed boost.

In 1977 V. Michael Hogan, for Converse's second edition, discussed augmentation pharyngoplasty with a port size of less than 40 mm.\(^2\) or with the anteroposterior deficiency less than 4 mm.:

While theoretically sound under these strict criteria, the technique itself has not been perfected in that there still remains an unacceptable degree of complications. The complications include extrusion of the implant, infection, and inferior migration with loss of the surgically restored competence. Injected fluid also has a tendency to migrate in the posterior pharyngeal area.

This general approach to correction of velopharyngeal incompetence has never greatly appealed to me. The most that can be accomplished is usually so little. Yet it can be argued that when so little is needed and a simple procedure can provide it, this is the route of choice. It is not that easy to determine the exactly effective position for the projecting mound. I have recently acquired a case in which the projection is certainly present but \textit{far too low} to be effective, as demonstrated by Berkowitz with x-ray films showing palate at rest, vocalization of un to show ability of
velum to elevate, and sustained vocalization of s to determine capability of the soft palate to stretch in anteroposterior length.

It is always a temptation to take the easy road to contour building by simple insertion of foreign body substance, and there is no doubt that we are getting closer to the ideal “inert” material. In the area of the posterior pharynx, however, solid implants have been notoriously unsuccessful, with a high rate of extrusion, and fluid injections are still undependable and likely to migrate. Homologous cartilage will usually absorb, and autogenous cartilage, the most reliable of the group, requires a separate operation and the extra scars. Certainly the insertion incision should not lie over the implant but be placed well below. A tacking suture through the mucosa, picking up prevertebral fascia below the implant to close the tunnel against migration, is indicated. Yet except in the “minimal” case, there are better ways.
LONG before surgery of the palate had been developed, obturators were in use. According to historical scholar Blair O. Rogers, as noted in *Cleft Lip and Palate*, 1971:

Interestingly, the earliest evidence of a simple, retentive dental prosthesis was found at El Gizeh, dating from the end of the Old Empire (circa 2500 B.C.). It was made of gold wire, linked together the lower left second and third molars, and had been woven around their gingival margins. Thus began man's early attempts to construct the intraoral prostheses that played such an important role in subsequent centuries in the evolution of cleft palate therapy and surgery. . . . Despite the supporters of Amatus Lusitanus as the inventor of the obturator [B. W. Weinburger], Paré was familiar with palatal obturators as early as 1537 to 1539, since he had observed their use many times "... in the battles fought beyond the Alps."

In 1560 Lusitanus, previously of Ancona, was probably the first to describe what is known today as a palatal obturator. A Greek nobleman presented a permanent luetic fistula of the palate to Lusitanus, who designed a prosthesis. These are his words, translated by Joshua Leibowitz of Hebrew University in Israel while at Yale:

Pay attention to the way . . . I invented the following extraordinary artifice which made possible a correct and distinct speech, as if he had never had any illness.

I ordered a goldsmith to prepare a golden-headed nail; the head of the nail was round and broad enough to close the total circumference of the foramen. Whereas the tip of the nail was narrow and round . . . and to this tip a small sponge was fitted. . . . This the patient had to introduce into the foramen where it expanded with moisture and so remained fixed in position.
This obturator was removed twice daily for cleaning. While it was in, the patient’s speech was "elegant"; when it was out, totally deficient.

Jacques Houllier’s mention of the use of wax or sponge to plug palatal perforations suggests that such primitive obturators were already in use by the middle of the sixteenth century, when buccopharyngeal syphilitic ulcers and palatal perforations were prevalent and recognizable.

In 1561 Pierre Franco, a Huguenot surgeon of Paris, wrote:

Those who have cleft palates are more difficult to cure: and they always speak through the nose. If the palate is only slightly cleft, and if it can be plugged with cotton, the patient will speak more clearly, or perhaps even as well as if there were no cleft; or better, a palate of silver or lead can be applied by some means and retained there.

In 1564 Ambroise Paré called his small obturators couvercles and only in 1575 changed the name to obturateur, which Rogers conjectured was probably the first time in medical history that the word obturator was used. Paré, referring only to traumatic and luetic palatal defects, explained his technique of filling the cavity of the Palat with a plate of gold or silver, a little bigger than the cavity itself is. But it must be as thick as a French Crown, and made like unto a dish in figure; and on the upper side, which shall be towards the brain, will become more swoln, and puffed up; so that it will fill the concavity of the Palat, that the artificial Palat cannot fall down, but stand fast and firm, as if it stood of itself.

Since surgical correction of a hard palate defect offered difficulties for centuries and, as Rogers has noted, surgeons of the Middle Ages avoided surgery of the palate like the plague, the prosthetic aids of the Renaissance deserved praise and were used for about 200 years. The principle was improved in 1728 by Pierre Fauchard, the father of modern dentistry, when he inaugurated a fixation of the obturator to a dental prosthesis. He described five different obturators of a sophisticated design, some with movable wings operated by screws and each covered with soft sponges, which could fill in most palatal perforations, no matter how irregular their margins. These were illustrated in Plate 38 of Fauchard’s *Le Chirurgien Dentiste, ou Traité des Dents*, 1746.
In 1757 Bourdet improved palatal obturators by fixing them, not to the palate itself or inside the nose, but, by means of lateral clasps, to the teeth. In 1820 Delabarre constructed a rubber prosthesis with bands and clasps that utilized the palatal muscles to move the velar section of the prosthesis. Mineral teeth were attached to the palate by means of springs. A movable part made of elastic gum was attached to restore the velum and uvula.

Mohamed Aramany of the University of Pittsburgh, studying the history of prosthetic management of cleft palate, reported that James Snell was believed to be the first to attempt the treatment of congenital clefts with obturators in 1828, about 300 years after Paré wrote his "Surgery," describing an obturator for luetic and traumatic clefts. Snell's attempt to restore the soft palate stopped short of occupying the pharyngeal space. In 1841 Stearn, who had a congenital cleft himself which had undergone a few unsuccessful operations, attempted to construct an appliance of his own and was the first to extend the speech aid into the pharyngeal area.

In 1845 Simon P. Hullihen of Wheeling, West Virginia, noted:
Where the osseous palate is likewise involved, more or less of an aperture will of course remain which must be closed either through the medium of granulations, or by a gold obturator or artificial palate before much benefit can be derived.

In 1860 McGrath introduced a fixed prosthesis and extended the velar section into the nasopharynx. Also in 1860 Norman Kingsley worked with Stearn to construct a speech appliance for a severe bilateral cleft and later improved Stearn’s design by simplifying it. For this advance he received a gold medal at the American Dental Convention at Saratoga in 1863.

In 1867 Wilhelm Suersen, a German dentist, also improved Stearn’s appliance, constructing a fixed prosthesis, and emphasized the importance of the muscle activity of the pharynx, particularly in securing contact of the pharyngeal section of the prosthesis with the pharyngeal musculature to occlude the nasopharynx temporarily. In 1880 N. Kingsley was the first to advocate speech therapy following the construction of an obturator.

In 1878 Passavant employed a collar-button obturator similar to that of Gariel, to maintain posterior displacement of the velum after a transverse incision.

In 1885 Wolff of Berlin advocated the use of Schlitsky’s soft rubber pharyngeal obturator after successful cleft palate operations in all cases in which the velum was too short to reach the wall of the pharynx. In 1894 Wolff discarded this obturator for Hahn’s hollow hard rubber pharyngeal obturator, which, except for the material, was constructed like the Schlitsky one.

**EARLY COMBINED USE OF PROSTHESIS AFTER SURGERY**

In 1912 Pickerill of New Zealand combined a prosthesis with palatoplasty in a rather unusual and unphysiological way.
In 1921 C. S. Case developed the velar obturator, designed with careful attention to the palatopharyngeal muscles that contacted the prosthesis. Also in 1921 dental surgeon Kelsey Fry insinuated his appliance into the combined hole of the anterior hard palate and the defect between hard and soft palates created by Harold Gillies to achieve a pushback of the velum. This technique is described in Chapter 25.

**COMBINED PROSTHESIS FOR TEETH, FACIAL CONTOUR AND PALATE OBTURATOR**

In 1932 in the *Lancet* H. D. Gillies, with T. P. Kilner, revealed his early deciphering of one of the major problems in secondary cleft surgery.

The commonest contour deformity seen in old hare-lip and cleft palate cases is produced by flatness of the lip and depression of the nose. It is obvious that the flat lip is caused by a lack of forward projection in the underlying maxilla, most marked when the premaxilla has been removed, but present in a lesser degree in a large proportion of lips, either bi- or uni-lateral.

The type of depressed nose encountered may be defined as one which as a whole, is situated nearer the vertical axis of the body than normal. . . . This nasal deformity has a more complicated origin than that of the lip. Factors observed include: (1) the backward displacement of the maxillae resulting from the scar tissue pull which follows successful closure of the palate cleft; (2) a definite under-development of the normal amount of bone in those parts of the maxillae which border on the pyriform opening; (3) the backward pressure of a tight lip; (4) a definite failure in the forward growth of the nasal septum. . . . The natural corollary to the backward displacement of the maxillae is that the upper teeth come to lie well inside those of the lower jaw, creating inefficient mastication and an ultra-prominent lower lip.

In 1932 Gillies and Kilner readvocated the buccal inlay and prosthetic principle first developed by Gillies and Fry in 1921 for the cleft palate patient but admirable too in the contracted faces and noses of the luetic deformity. In fact, intranasal prosthetic support attached to the upper plate could be introduced into the
luetic, skin-graft-lined nose

so that it is perfectly possible for a patient to pocket several different-shaped bridges and change his racial and facial characteristics by a simple sleight of hand.

A preoperatively prepared, simple metal cap splint was fixed to the existing teeth. It held a small adjustable tray in front to support the molding material used to build forward the contour and carry a Thiersch graft to line the pocket. Through an upper buccal sulcus incision, the soft tissues of the lip, nose and cheeks were freed from the underlying retroposed maxillae. Into this raw area a Thiersch graft was fitted, raw surface outward, taken from the hairless inner aspect of the upper arm and mounted on the molded stent over the tray which was fixed to the cap splint. Once the graft had taken and the lined pocket had been established, a permanent upper denture was fitted to replace missing teeth, hide misplaced ones, block the oronasal communication while leaving the nasal airway free, and push forward the lip and nasal base and occlude its teeth normally with those of the mandible.

As noted by Gillies and Kilner:

The whole character of the face is altered for the better. . . . The drawbacks are few. The patient is doomed to wear a denture (how many of us escape?): very occasionally a few drops of imbibed fluid leak through the nose; and occasionally an irritant rhinorrhea persists for a time.

There are times, even today, when this approach is used and on rare occasions is the method of choice.

COOPER

Herbert K. Cooper, an orthodontist of Lancaster, Pennsylvania, in the late 20's and early 30's began to see many cleft palate wrecks. General surgeons, after a full morning of colectomies and thyroidectomies, would turn over the cleft palates to the junior surgeon, and consequently many cases were botched, ending up with fistulae and scarring. Cooper felt that no further surgery was indicated in such disasters, and during his dental restoration he added a bulb to the prosthesis to help the palate. In the late 30's Dorrance became aware of Cooper's success with obturators and made an effort to combine forces.

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Robert Ivy, a friend of both Cooper and Dorrance, recalled with glee an episode in a cleft palate clinic about 1938. The heavy, dogmatic, domineering, over 6 foot Dorrance finally irritated the quiet, unassuming, 5 foot 8 inch Cooper into throwing down the gauntlet. To a Dorrance boast about his pushback procedure, Cooper responded:

I can bring 100 cases that have been restored dentally which have good speech, George, if you’ll bring a hundred palate cases which have had your “push-back operation” to the same meeting. We’ll have a show-down!

Ivy said Dorrance never took Cooper up on this challenge.

**FIXED BRIDGE**

Egil P. Harvold, now of the University of California, while at the University of Oslo in 1947 first began studying maxillary development in cleft lip and palate cases. He showed that the main factor in the development of the cleft palate malocclusion was an inward rotation of the maxillary segments around a fulcrum in the region of the maxillary tuberosity, rather than mere individual tooth movement. For correction of this, Harvold demonstrated in 1954 and 1963 that the dislocated segments could be relocated by orthodontic means and then the position of the individual teeth could be corrected by standard orthodontics. In 1951 and 1967 A. Böhn, in cooperation with Harvold, solved the prosthodontic problems by establishing that the postorthodontic results could be permanently retained by means of a relatively short splint across the cleft. Besides retention, the splint provided missing teeth and correction of malformed teeth in the cleft area. Following this regimen, T. Ramstad of the University of Oslo, in the 1973 *Cleft Palate Journal*, presented several impressive cases in which the postorthodontic arch form had been maintained while the dental abnormalities were corrected. He noted:

The fixed bridge is the prosthodontic treatment of choice.

Shown here is one of his bilateral clefts after orthodontic treatment, with an eight-unit retention bridge with removable fistula obturator in position and incisor relationship satisfactory. Treatment results with reference to the postprosthodontic adult
occlusion in 63 unilateral and 19 bilateral complete cleft cases were noted:

No buccal crossbite occurred in 63.5% of the unilateral- and in 78.9% of the bilateral cleft cases. Positive overjet and overbite occurred in almost 90% of the unilateral- and in all the bilateral cases.

MORE COMPLEX APPLIANCES

In 1965 A. C. Roberts presented complex obturators attributed to Fauchard and designed to open in the cleft to provide retention; movement of the wings is achieved by using the key.

Before palatal surgery had been developed, and later when less sophisticated and more traumatic surgery had so scarred the palate that function was impaired, and also in cases of severe congenital insufficiency of palatal tissue, the obturator has been of use. As surgery has improved, the obturator has gone on the shelf, but in some areas under certain conditions it may be of value.

MODERN STAND ON PALATE PROSTHESIS

Robert T. Millard, director of speech and hearing services at the Lancaster Cleft Palate Clinic, acknowledged that the majority of clefts can be closed by operative procedures. In 1971, for *Cleft Lip and Palate*, he presented some interesting guidelines for cases in which a prosthesis was under consideration:

*Indications for Prostheses in Unoperated Palates:*

1. A wide cleft of the soft palate with insufficient local tissue available to accomplish a functional repair
2. A wide cleft of the hard palate which cannot be closed with a vomer flap or other local tissue
3. Neuromuscular deficit of the soft palate and pharynx
4. Cases with a justified medical contraindication to surgery, such as a blood dyscrasia, or when surgery is delayed
5. Expansion prosthesis for improvement of spatial relationships
6. Combined prosthesis and orthodontic appliance
Indications for Prosthesis in Operated Palates:
1. Incompetent velopharyngeal mechanism with a deep pharyngeal space behind the velum
2. Surgical failures—fistulas in the alveolus, hard, or soft palate.

Contraindications for a Prosthesis:
1. Feasibility of primary or secondary surgical repair based on definitive diagnostic methods
2. Severe mental retardation
3. Uncooperative patient and parents
4. Uncontrolled dental caries, partial or complete anodontia, dentinogenesis imperfecta, and amelogenesis imperfecta
5. Lack of a trained prosthetist

I. Kenneth Adisman of New York University Dental Center, chosen to write the chapter on “Cleft Palate Prosthetics” for the 1971 Cleft Lip and Palate, was trained under Walter Wright and since 1971 has worked with John Converse at the New York University Medical Center to integrate dental treatment with reconstructive plastic surgery and speech therapy. According to Adisman, there are three general types of prosthesis:

1. The fixed or immobile prosthesis which remains stationary, permitting the palatal and pharyngeal musculature to contract and function against its lateral and posterior surfaces. This is the accepted type for prosthetic therapy.
2. The hinge or moveable prosthesis popular in the nineteenth century which attempted to imitate the soft palate but was too complicated and difficult to make and maintain.
3. The meatus type extended into the nasal cavity instead of the pharynx with an airway provided by a perforation of the nasal extension. This type is indicated for unrepaired hard and soft palate clefts.

Adisman considers prosthetic intervention indicated for feeding aids and where surgical closure is not deemed advisable or practical because of poor health, extensive clefts, lack of local tissue, collapsed arches or failed surgery, or in conjunction with surgery. He forwarded examples of his cleft palate prosthesis. The modern standard prosthesis is composed of three parts:

1. The maxillary section, a simple acrylic resin base covering the hard palate and retained on the teeth by flexible gold wire clasps.
2. The palatal extension section, a cast metal bar that traverses the length of the soft palate and ends in a loop for retention of the nasopharyngeal section.

3. The nasopharyngeal section, which ends in a bulb of the required size, depending on the deformity. It is usually made of a clear methyl methacrylate resin so that irritation of the pharyngeal mucosa can be detected. It must be large enough to provide a velopharyngeal seal during phonation and swallowing, but not block the nasal passages for respiration. In unoperated cases, most pharyngeal bulbs are situated high in the nasopharynx, with the lower area of the bulb in line with the posterior nasal spine and palatal plane. In postoperative cases the bulb is generally placed lower in the nasopharynx because the velar tissue aids in partially closing the velopharyngeal port but not so low as to be dislodged by the tongue during swallowing.

With the same artistic streak that attracts him to the beaches for seashell collecting, Adisman constructs cleft palate prostheses as shown to improve both function and appearance, to help the patient "in taking a useful role in society."
Prostheses can be constructed as appliances for palatal training, stimulation or lifting. S. Berkowitz of the University of Miami expressed his thoughts about a speech aid prosthesis:

Aram and Subtelny report that when the synergistic behavior of the velar and pharyngeal musculature is inadequate in creating sphincteric type of lumen closure (velopharyngeal closure), speech can be assisted by a prosthetic aid. The speech bulb (pharyngeal extension), usually constructed of acrylic resin, must conform to the dimension, shape and position of the velopharyngeal opening which exists during function. Therefore, the proper positioning of the pharyngeal section is critical to prosthetic success.

Prosthetic failures, that is, those which do not improve speech, result when pharyngeal sections are inappropriate in size, shape or placement.
They state that velopharyngeal closure is closely related to the palatal plane. From 4 to 8 years of age, it is slightly below the palatal plane; after 9 years of age, contact is slightly above the plane. Also, the anterior tubercle of the first cervical vertebra is a poor landmark for the placement of the pharyngeal section. The pharyngeal section must make contact with the posterior pharyngeal wall and be contacted by the muscles of the lateral aspects of the nasopharynx as well as the soft palate during function.

**Incompetent Speech Aid Appliance**

This velum was heavily scarred and immobile. It failed to elevate on function. The maxilla was hypoplastic. The speech bulb was placed very low due to the nature of the velum and therefore failed to reduce nasal resonance. Although it made contact with the posterior pharyngeal wall and was of adequate width, it still did not function and do all it should have done to improve speech. Had it extended more superiorly into the pharynx it would have reduced nasal resonance.
TEMPORARY OBTURATOR AS STOPGAP PENDING POSSIBLE LATER SURGERY

Robert W. Blakeley, a tall, lanky lad growing up in the Michigan outdoors, got to college via the high hurdles with a strong contention for the Olympic Games. After a year and a half of law school, he discovered the excitement of speech pathology and ended up with three degrees in this specialty. At the University of Oregon, he has pioneered systematic reduction of temporary speech prosthesis for cleft palate patients in whom surgery was unsuccessful. Here is a resumé of his comments in 1977:

It is important that we interrupt nasal emission early enough for each child in order that this nasal emission not interfere with development of the 16 air pressure consonants, or, that we stop the nasal air leak early enough so that errors already occurring do not become firmly habituated; early compensatory errors are usually relatively easily alterable by the patient and/or clinician if normal oral breath pressure is provided early enough, as I noted in 1972. Substantially habituated compensatory errors are difficult to "undo"
even with formal speech habilitation procedures. The speech goal for children with repaired cleft palate should be prevention during pre-school years, not correction in grade school after habituation.

The temporary speech prosthesis can be constructed, placed and the child obturated within a period of two to seven days depending upon manageability of the child and cooperation of the parents. Obturation, of course, is the goal. Stop the nasal emission of air early enough and the child will develop normal articulation on his own or with minimal parent/professional assistance. In virtually all instances the obturator will provide normal voice quality (or slight temporary hyponasality) when it is placed in the child's mouth.

The Oregon Crippled Children's Program at the University of Oregon presently has 125 children who wear a temporary speech prosthesis in a program encompassing some 750 patients. Obturators have been provided for children as young as two years, eight months.

The obturator reduction program works something like this: Initially, an obturator, of necessity, is made large enough to eliminate hypernasality and nasal emission. This virtually always entails "overimpingement" upon the musculature of the V-P area at about the horizontal plane of the hard palate. The patient tends to "draw away" from the obturator initially, or may habitually relax the pharynx to produce some sounds because that has been his/her learned response. Thus one must "force" oral emission via the obturator, taking care not to impinge too firmly upon soft tissue overlying the atlas, in order to get control of the hypernasality and nasal emission. Thereafter, the recommendations are specific to consonant articulation alone. No other management of the voice is required save manipulation of the size of the obturator.

After the patient has worn an obturator four to eight months that patient is an habitual oral speaker (with the obturator in place) and is altering articulation by maturation alone, by parent assistance or by formal help from a speech pathologist. It is at this time that systematic reduction of the obturator can begin. This is carried out by the speech pathologist and dentist using a combination of speech testing (utilization of a nasal listening tube and the nasal "flutter" test), pressure indicator paste on the obturator during speech testing and oral inspection. The amount and place of reduction is thereby determined in gradual steps at each appointment (e.g., 1 to 3 mm on each side of the obturator and 1 mm from the anterior) and continues until the speech pathologist begins to detect subclinical signs of hypernasality and/or nasal emission. The reduction process is then discontinued, a model of the obturator portion is reproduced in dental stone as a permanent record, and the patient returns in approximately four months for the same approach to obturator reduction because his palatopharyngeal musculature has usually "made up" the difference by this time in an
apparent physiologic "maintenance-of-the-status-quo" for complete V-P closure. Obturator reduction continues in this fashion over six, nine and twelve month intervals until the limits of V-P compensation are approached.

Most of the patients at this point in their management have both normal voice and articulation. Thus any surgical procedure (usually a pharyngeal flap) becomes a substitute for the prosthesis in a child with normal speech. It is felt by the surgeon [V. V. Lindgren], dentist [R. M. Adams], and speech pathologist [R. W. Blakeley], as published in 1964, that the patient, because of a normal monitoring system for speech and maximally compensated V-P musculature, is a far better candidate for secondary V-P surgery for speech purposes than he would have been prior to use of the speech prosthesis.

In one study by me in 1970 of 60 obturator patients, 19 percent of the obturators were reduced in size to the point of removal leaving those patients with normal voices. Thirty percent of the 60 were referred for surgical substitute with good results after it was felt that their obturators could not be additionally reduced in size. The remainder of the patients continued under the obturator reduction program.

One cannot account exactly for the amount of V-P compensation (muscle hypertrophy) in an obturator reduction program for any given patient. Some patients, no doubt, require no compensation of musculature but only need obturation and obturator reduction ("weaning") to "teach" the V-P musculature how to function optimally during speech. However, some generalizations can be made. Based upon the historical dental stone models of obturators reduced, the greatest compensation obviously occurs in the lateral pharyngeal walls and compensatory hypertrophy of V-P musculature does take place in a substantial number of patients. In the 60 patient study noted, the mean lateral reduction was 14.5 mm while the mean A-P reduction was 2.9 mm.

In 1975, in the Transactions of the Sixth International Congress of Plastic and Reconstructive Surgery, T. Hirose of Matsumoto, Japan, recalled that 10 years before, a case of purpura in a cleft palate had prevented early surgery. This precipitated the early fitting of an obturator to facilitate eating and speech until such time as surgical closure was indicated. Hirose’s subsequent experience with the use of temporary obturators proved that they were most effective when they covered the cleft correctly and extended to the posterior pharyngeal wall. When the velar piece fitted snugly into the cleft and its tip almost touched the posterior pharyngeal wall, five out of eight patients obtained normal speech.
When the velar piece, made of soft elastic silicone rubber, covered the cleft, the tip again almost touching the posterior pharyngeal wall, seven of nine patients obtained normal speech.

Hirose noted:

The proper age to begin wearing the obturator seemed to be two years, because at that time the dentition of first molars is almost finished and we can use them to hold the obturator with clasps. . . . The children soon liked to wear the obturators and they did not like to speak or eat without the obturators. . . . In nine cases of which the pushback operation was performed at a later date, all obtained normal speech by this method and all cases retained normal speech.

FOR FLOATING PREMAXILLA

A prosthesis can be used to fix a floating premaxilla. A fixed partial denture in the teenage child consists of acrylic or vinyl resin over cast gold copings on abutment teeth, and acrylic or vinyl resin pontics for the missing teeth. The result is fixation of the premaxilla to the lateral maxillary processes, a functional occlusion and normal cosmetic appearance.

OVERLAY DENTURE

Superimposed prostheses are indicated for patients with cleft palate who require occlusal and cosmetic improvement because of underdeveloped maxilla or overdeveloped mandible to correct the disharmony and malrelationship between the two, where for
some reason corrective surgery is contraindicated. Overlay dentures are indicated for

1. Patients who had premaxillary resection early in life resulting in maxillary contraction, leaving a foreshortened occlusal relationship in consequence of the lack of vertical, lateral and anteroposterior growth.
2. Patients with floating premaxillae in abnormal relationships so that maxillae are contracted.
3. Patients with lip collapse and tightness, in whom the superimposed prosthesis supports and plumps the lip for a more harmonious facial contour.
4. Postoperative cleft palate patients with few or minimal number of abutment teeth, exhibiting collapsed occlusal relationships due to inhibition of maxillary growth as compared to mandibular development.

As the prosthodontist comes to the aid of the surgeon, the surgeon can be of assistance to the prosthodontist. A scarred palate may be redivided to create a more favorable nasopharyngeal area for placement of this section of the prosthesis. Reconstruction of a labial sulcus or excision of fibrous bands and adhesions can facilitate the placement of a prosthesis. Resection of an obstructing, floating premaxilla may create a better environment for a prosthesis. And in the absence of teeth, creation of retention perforations in the mucosa may allow mucosal inserts to aid in retaining the prosthesis.

Robert Millard emphasized the importance of having the speech pathologist and the prosthodontist work together with the patient and the parents to achieve the optimal use of the prosthetic speech appliance.

Prostheses can be of inestimable value in maintaining function while one is awaiting the optimum time, in respect to growth, for surgery. From the surgeon’s point of view after that, the need for a prosthesis should be extremely rare, as it indicates either failure of surgery or unwillingness or inability to carry out adequate secondary surgery.
Libby F. Wilson-Mackby of Rancho Los Amigos Hospital, California, emphasized the value of various prosthetics before and immediately after cleft palate surgery. In 1978 she noted:

Prosthetic devices can positively affect the outcome of surgical procedures. When placed in a neonate with a palatal defect, intra-oral appliances help to obturate the cleft. During feeding, the appliance provides a firm surface against which the infant's tongue will trap the nipple and facilitate delivery of fluids. It may also afford some protection to the delicate nasal mucosa which would otherwise be exposed to irritants from the oral cavity.

After lip closure, this or similar devices help retain position of the palatal shelves and promote more favorable maxillary-mandibular relationships. Maxillary arch form can be regulated by modifying the appliances as the child grows.

When palatal repair is performed the suture line can be protected from the infant's tongue by contouring a plastic container lid to the arch and securing this wafer in position with absorbable suture materials.
VII. Jaws
Introduction to Part VII

When the cleft anomaly has occurred on the framework of a face which, without the cleft, would have been prognathic (Angle class III) or retrognathic (Angle class II), it tends to increase or decrease, respectively, the absolute occlusal discrepancy between the two jaws. Edward Angle of Pasadena was the modern father of orthodontics in the early 1900s.

Cephalometric analysis may aid in the defining of the deformity, but in the final analysis, the decision as to which structure is deformed and which should be operated upon—the maxilla or the mandible—will need to be made on a clinical basis, with an understanding of what would constitute the most pleasing esthetic relationships for the particular patient’s face. Cephalometric analysis takes the sella-nasion (SN) line as the fixed line against which to measure the most anterior point of the maxilla (point A) and the most anterior point of the mandible (point B). Dingman and Dodenhoff’s cephalometric x-ray tracings demonstrate the differences between normal relationships, pseudoprognathism, and true prognathism.

In severe maxillofacial deformities, the cephalometric baselines themselves become affected and invalid, as in the patient with Crouzon’s disease with a steeply tilted anterior base, or in the patient with hemifacial microsomia, who has a short cranial base on the affected side. The majority of adult postoperative cleft patients will have class III malocclusion due to maxillary hypoplasia, and generally the maxilla—the blighted structure—should be moved forward rather than the mandible backward, to obtain both proper dental occlusion and a satisfactory facial profile. When from cephalometric determinations the mandible is more
protuberant than the maxilla is recessive, the mandible may be moved back.

Any major discrepancy in the sizes of maxillary and mandibular arches is usually caused by the maxillary deformity. As a rule, the maxilla should be expanded, but again, in some cases the deformity will be predominantly due to an overlarge mandibular arch which will need to be reduced by a body or symphyseal ostectomy.

Correcting priorities

In 1959 Heinrich Köle of Graz made this sound observation:

The choice between orthodontic and surgical treatment is based on the severity of the deformity and the age of the patient. Generally surgery is preferred when the malformations are very pronounced or when bone growth has ceased.

It is the opinion of Obwegeser, Tessier, Dautrey, Pruzansky, Aduss and others, as well as Wolfe and Berkowitz in our unit, that mandibular prognathism, as we define it by cephalometric analysis, is not more common in the cleft lip and palate group. Furthermore, our unit has not had gratifying results in treating mandibular pseudoprognathism (i.e., retromaxillism) with orthodontics when there was a skeletal discrepancy between the basal alveolar bone of the maxilla and mandible. Many of our patients, although they end up with “satisfactory” dental occlusion, have required onlay bone grafting to these maxillae, which still possess their recessed, hypoplastic appearance.

The surgeon must work closely with the orthodontist in defining the deformity and planning the proper procedure. The orthodontist, in turn, must know which cases should not be treated by orthodontics alone. Orthodontics treats the malalignment of teeth, but when the supporting skeletal structures—the alveolar ridges of the maxilla and mandible—are in poor relationship, surgery must be performed before a satisfactory dental and facial result can be obtained.

Surgical procedures most commonly used in cleft patients are:

1. Segmental procedures.
2. Procedures for mandibular recession.
3. Procedures for maxillary advancement.
4. Onlay bone grafting procedures for patients with orthodontically obtained class I occlusion but persistent maxillary hypoplasia.

A modern, premier hard tissue surgeon for correction of the postoperative cleft lip and palate, mandible and maxilla, is Hugo Obwegeser of Zurich. In the introduction to his 1971 chapter for *Cleft Lip and Palate*, he stated:

Various degrees of residual jaw deformities and displaced teeth are usual sequelae to primary closure of clefts of the lip and palate. They have been present in the past, they are still seen, and, I believe, some of them will still occur in the future. New surgical techniques notwithstanding, there is no panacea in cleft surgery. The cause of these anomalies is attributable to four factors: (1) genetic, (2) type of surgical procedure used, (3) skill of the surgeon, and (4) the orthodontic treatment. . . .

Most patients with malposed jaws have an altered, often severe facial disharmony. . . .

In cleft cases, some supplementary correction may be required on the soft tissues; however, this should follow the correction of the bony parts. As in any type of maxillofacial surgery, especially in the correction of secondary jaw deformities, one must adhere to the principle, "first the bone, then the soft tissues."

Obwegeser generalized:

I believe that in a cleft case it is extremely difficult for one to postulate exactly what the interrelationships of the facial bones would have been had they not been changed by both the cleft deformity and the further disruptive forces of surgical intervention. For this reason, the surgeon’s treatment planning is greatly influenced by imaginative and intuitive factors.

Create the best possible occlusal relationship; this is a basic guide. Most of these patients have an Angle Class III type of appearance. In the past, I operated primarily on the mandible, and the results were only marginally satisfactory. The operation on the mandible only, often created a pronounced retrodisplacement of the middle third and lower third of the face. Today in cleft cases I usually operate on the upper jaw only. I seldom operate on both the maxilla and mandible and very infrequently on the mandible exclusively. For profile considerations, when the maxilla is moved forward, I strive to create a Class II occlusion, thus slightly overcorrecting the occlusion.
MANDIBULAR surgery, although not indicated as often as was initially thought, has an important place in the total correction of secondary cleft deformities. The original cleft with its varying degrees of discrepancy and distortion, which occur in addition to the secondary effects of trauma, scar contracture and their retarding influence on early bone growth, places the main surgical problem in the maxilla. Some faces, however, are destined by genes to grow prognathic mandibles. This factor, of course, compounds the problem but also necessitates mandibular corrective surgery. Should genetic destiny produce a retrognathia, although it may blend better with the hypoplastic maxilla of the cleft deformity, the end result is a deficient face which might conceivably deserve both maxillary and mandibular correction.

Not surprisingly, some of the great maxillofacial centers of the world that have contributed to the treatment of mandibular prognathism have been located in the Hapsburg belt. As pointed out by Grabb, Hodge, Dingman and Oneal in 1968 in *Plastic and Reconstructive Surgery*, Charles V was the first of the Hapsburgs to rule Spain. His portraits show a severe mandibular prognathism with Angle class III malocclusion. Historian Rhea Marsh Smith wrote that Charles' protruding lower jaw caused his mouth to hang open and gave him the appearance of an imbecile. It is reported that when Charles first came to Spain from Ghent, a Spanish peasant shouted to him:

"Your Majesty, shut your mouth, the flies of this country are very insolent!"

Genetic studies of the Hapsburg family have shown that their facial characteristics were transmitted as a single dominant trait.
The genetic inheritance was practically assured by the family tradition of close intermarriage as a means of preserving the house of Hapsburg. Charles and his relatives suffered from realistic artists of their day, who painted what they saw without regard for flattering their subjects. Since members of royalty were painted frequently, it was possible to trace the effect of aging on their faces—beautiful and delicately featured children acquired the grossly distorted features of the Hapsburgs by the mid-teens, more pronounced with each passing year.

Mandibular prognathism is not always transmitted by a single dominant gene, as shown by Schulze and Weise, who found transmission by an irregularly dominant mode of inheritance with variable penetrance.

**TIMING OF SURGERY**

In 1971 R. O. Dingman and T. G. Dodenhoff of the University of Michigan stated:

Operations should be deferred until patients have attained practically full mandibular development. In females this occurs by 18 years of age and in males usually by the age of 20. Growth may be considered complete when identical cephalometric X-ray studies, taken at 6-month intervals, can be superimposed exactly. Growth after age 20 is uncommon. Earlier operation may be indicated in patients with severe deformities and a serious psychological reaction to their deformity. The best results from osteoplastic operations upon the mandible are noted in the young adult age group. Patients beyond the age of 40 may have slow or incomplete healing as a complication.

**MANDIBULAR BODY OSTECTOMY**

In 1848 Simon P. Hullihen of Wheeling, West Virginia, was faced with a 20-year-old patient who had an elongation of the mandible caused by a burn contracture of the lower lip and neck, present since the age of 5 years. Hullihen carried out a V-shaped ostectomy of the anterior body of the mandible bilaterally, which allowed the distal portion to be moved back into its proper position.
In 1896 Edward H. Angle advised bilateral resection of the mandible through the entire body for a patient with a progressive type of prognathism. This patient, however, came under the care of Vilray P. Blair of St. Louis, who resected a quadrilateral section from either side of the jaw, brought the teeth in occlusion, wired them in place, but had difficulty holding the jaw fragments in occlusion.

In 1907 Blair discussed his mandibular ostectomy:

This operation presents three distinct problems: 1. the cutting of the bone, which is the easiest of the three; 2. the placing of the jaw in its new position; and 3. holding it there.

Blair discounted the seriousness of injury to the nerve:

We need not concern ourselves with the consequences of cutting the inferior alveolar nerve and artery. Normal sensation eventually returns to the teeth after their section.

Blair wrote in 1915:

Before operating upon my first case of mandibular protrusion, I carefully considered the best site of attack. It would be a natural procedure for a simple forward position of the body of the mandible to make a cut in the ramus and push the jaw back to its proper relationship, but the fear of crowding the retroramal structures and thus possibly to interfere with free opening, decided me to remove a section from the body itself.

This operation was first done by Blair in 1907:

The result was obtained not only by taking out a section of bone on each side and setting back the mental piece, but the premolar teeth had to be crowned to bring them into occlusion.

To avoid opening into the mouth and the infection that invariably followed, Blair developed the subperiosteal osteotomy, passing a needle around the mandible carrying a wire saw which he used to divide the bone.

This approach was advocated later by C. Henschen and R. Schwarz in 1928–1929 and V. H. Kazanjian at Harvard in 1941. The refinements of the method were introduced in 1912 by W. Harscha and J. Eisenstaedt, independently of each other and both in Surgery, Gynecology and Obstetrics. They described short-
ening the horizontal ramus through a 2½ inch incision beneath the border of the mandible. Subperiosteal saw resection of the determined amount of bone, without entering the mouth, was followed by wire sutures to the bone and immobilization with interdental wiring.

In 1941 Gordon New and John Erich of the Mayo Clinic, Rochester, Minnesota, reviewed the various methods of treating mandibular prognathism. They expressed preference for bilateral resection of a segment of the mandible in the bicuspid or first molar regions... and described division of the segment of the mandible with a motor-driven circular saw from below up, near the mandibular canal, and from above down near the canal with a Gigli saw. Then the bone was chipped out with a chisel, leaving a small amount around the nerve and vessels which was carefully picked off with a rongeur. They were more concerned about the nerve than infection from suturing the oral cavity, exclaiming:

Many surgeons consider severance of the mandibular nerve to be of little consequence, but those of our patients who had the mandibular nerve cut complained bitterly of subsequent numbness, and in some instances, normal sensation in the lower lip never was regained entirely.

Reed O. Dingman of the University of Michigan, Ann Arbor, while an undergraduate at Wayne State University, served one summer as the boxing and wrestling coach at a boys' camp in northern Michigan. He soon made friends with one of the other counselors, Freddie. When this young entrepreneur discovered that Dingman, besides playing football, was a middleweight on the university boxing team, he conned him into taking on all comers at the Saturday night fights in the small lumber mill.
towns. At $50 an appearance plus side bets, Dingman fared well until matched against the promising local champion, a lumberjack. After six tough rounds, a loss by a close decision and a look in the mirror at his bruised face and fractured nose, he decided to bypass the prize ring and proceeded to get his dental and medical degrees.

His firsthand knowledge of giving and receiving jaw trauma especially prepared him to pioneer the specialty of jaw surgery. In 1944 he described a two-stage procedure for correction of mandibular prognathism which removed bone of the horizontal ramus without interfering with the inferior alveolar nerve and its associated structures. In his first stage, under local anesthesia, through an incision along the crest of the alveolar ridge, the mucoperiosteum was elevated on the buccal and lingual surfaces. This maneuver allowed a resection on each side of the mandible with a bone drill, usually in the second molar region, the desired amount for removal being predetermined by the orthodontist. The saw cuts were not carried down to the nerve but extended on the outer surface of the mandible as a guide for the second stage. If necessary, a tooth in this area was extracted, but the bone was retained and the mucoperiosteum closed to seal off the oral side. Four to six weeks later, the second stage, usually under local anesthesia, was carried out through bilateral incisions parallel to and 1 cm. below the inferior border of the mandible in the area marked for resection. Subperiosteal resection of the bone block with drill and chisel, taking great care to stay clear of the mandibular nerve, was followed by removal of the medullary bone surrounding the nerve, including a hollowing out around the nerve to provide a safe resting place for excess nerve when the mandible was shortened. The bone fragments were approximated with 27-gauge stainless steel wire, and the orthodontic appliances, with the teeth held in occlusion, were secured by intermaxillary rubber band fixation. After several weeks, the bands were replaced by stainless steel wire.

In 1960 Dingman called attention to the possible use of his mandibular ostectomy in secondary cleft deformities:

A patient with underdevelopment of the middle third of the face and a normal mandible may give the appearance of having a prognathic jaw. Ostectomy of the mandible may be helpful in such cases.
After 14 years' experience of 95 cases, Dingman had reduced the operation to one stage, carrying out the intraoral portion exactly as previously described and closing this wound. Then, at the same time, he entered through the skin and carried out the previously described second stage, following it with the same fixation. In *Plastic and Reconstructive Surgery* he presented his one-stage ostectomy procedure:

He also presented a favorable step ostectomy for the patient with an edentulous posterior mandible.

In 1971 Dingman and Dodenhoff noted the advantages and disadvantages of the ostectomy of the mandibular body:

Advantages: (1) accessibility of the operative field, (2) the section of bone can be removed without injury to the inferior alveolar neurovascular structures, (3) the operation does not interfere with the physiological action of the muscles of mastication, (4) the fragments can be positioned and secured accurately and firmly, (5) a dental splint can be used to hold the fragments in place after only a short period (4 to 6 weeks) of immobilization, (6) open bite is less likely, and (7) good cosmetic results are usual. Its disadvantages are: (1) removal of bone, (2) removal of functional teeth, (3) not as applicable in extreme cases of prognathism, (4) the obtuse mandibular angle is not corrected, (5) if more than one tooth is removed on each side, the disparity in arch size makes bony appositional surface less than optimal, (6) if a gap of more than 2 or 3 mm. exists, the possibility of nonunion is present, and (7) the depressor group of muscles may cause open bite. . . .

. . . We believe the advantages far outweigh the disadvantages. We have corrected a deformity as large as 27 mm., and we do not feel limited in severe cases.

**Postoperative Care**

The ostectomy site is wired with a No. 24 stainless steel wire through drill holes in the bone. Intermaxillary fixation with
rubber bands initially will, by one week, have settled the lower jaw into optimal occlusal relationship. This allows replacement with stainless steel wire which will be maintained about six weeks.

Dingman's postoperative regimen is practical. The patient is placed on a high-protein, high-vitamin liquid diet and is usually discharged from the hospital on the second to fourth postoperative day. Oral hygiene is facilitated by the use of a small toothbrush or water pick and mouthwash irrigations every four hours.

Here are two of Dingman's cases, with Ponitz as the orthodontist.

1. South American teenage girl, who had unilateral lip and palate cleft closed in infancy in New York, revealed a tight lip, typical nasal deformity, scarred palate with contracted maxilla, and class III malocclusion when first seen by Dingman in 1955.

In 1957, lip revision, pharyngeal flap and rhinoplasty were performed, followed in 1959 by Dingman's one-stage bilateral mandibular ostectomy.

Intraoral: Flaps elevated from cuspid area of the mandible on both sides, first permanent molars removed, parallel bone cuts 7 mm. apart allowed removal of upper portion of bone and intraoral wounds closed. Extraoral: Skin incision 1½ cm. parallel with and below the angle of inferior border of mandible allowed exposure for continued resection of inferior mandible 9 mm. wide, salvaging the inferior alveolar nerves. The fragments were fixed...
with #25 stainless steel wire and the teeth brought into occlusion with rubber band traction. Six weeks later, unilateral rotation of the cleft nostril with alar lift improved nasal symmetry.

2. This 13-year-old boy had his unilateral cleft lip closed at 1 month and palate cleft closed in two stages at 18 and 24 months by oral surgeon Kemper at University Hospital, Ann Arbor. When seen by Dingman in 1960, he revealed velopharyngeal incompetence and class III malocclusion.
He had a setback palatoplasty and a pharyngeal flap and, at age 18 in 1965, a Dingman one-stage ostectomy resecting 1 cm. at the superior mandibular border and 1.5 cm. at the inferior border on the right, and 1 cm. superiorly and inferiorly on the left. The inferior alveolar nerve was preserved and the bone hollowed out to bed the excess nerve. Fixation was the same as in the previous case.

In 1977 Dingman acknowledged that in the past mandibles had been moved back when in fact maxillae should have been moved forward. He noted, however:

I think there are still some cases that have reasonably good maxillary development, with a true prognathic mandible deserving osteotomy.

**Subcondylar Osteotomy**

In 1897 Berger resected the mandibular condyles to treat prognathism. In 1898 M. Jaboulay and L. Berard reported their method of subcondylar osteotomy.

In 1921 Leon Dufourmentel of Paris, one of the early pioneers of plastic surgery, advocated condylectomy and mandibular retropositioning for prognathism. During my 1948 peregrinations as a plastic surgery student, I had the pleasure of dining with the senior Dufourmentels in their luxurious apartment, and at one time they had five different wineglasses at my place. It was impossible to lift one without striking another, and my side of the table began to sound like noon chimes in Notre Dame.
Leon Dufourmentel was chief of l'Hôpital Saint-Louis and did his mandibular work there. Today his equally famous son, Claude, is chief of this same hospital. It is 400 years old, having been set up by King Louis XIV as a stopover first aid station for him and his court on their way back to Versailles in case of accidents during hunting trips.

Francis Kostecka of Czechoslovakia was another contributor to mandibular surgery. Born in South Bohemia, trained in general surgery and specializing in stomatological surgery, he traveled to most of the important oral surgical centers in the world, including Vienna, Berlin, Geneva, Paris and London, with three months in Chicago with Brophy, studying cleft surgery. He returned to Prague to head the stomatological clinic at Charles University, and in 1926 at the Eighth International Stomatological Congress in Philadelphia, he presented his surgical treatment of prognathism. In 1931 Kostecka simplified the subcondylar osteotomy by the use of the Gigli saw. This method became known as the Kostecka osteotomy and enjoyed some popularity.

Dingman’s evaluation of this procedure is of interest:

A fascial interposition prevented union and resulted in a false joint. Destruction of the temporomandibular joints plus the abnormal pull of the pterygoid muscles makes this an undesirable procedure.

EARLY CONDYLECTOMY

In 1976 dentist Edmond A. Adler of West Perth, Australia, published a paper on “Early Condylectomy to Prevent Prognathism” in the Journal of Oral Surgery. It described how, through a standard endaural incision, stripping of the lower head of the lateral pterygoid muscle from its mandibular insertion and section of the condyloid process at the junction of the head with the neck were accomplished. Adler noted:

Bilateral condylectomy in young patients brings about cessation of anteroposterior growth of the mandible. If the condyles reform before body growth is complete, anteroposterior growth of the mandible recurs. Preliminary observations indicate that the procedure, used in ten young patients, reduces or prevents mandibular prognathism.
The *Journal* editor warned:

One must be careful in drawing a positive conclusion about the effectiveness of such a procedure from the current series of cases, since six of the ten patients were children with cleft palate and the correction involved adjusting a normal mandible to a retrusive maxilla, rather than the treatment of true prognathism.

In 1977 Harold K. McComb, also of West Perth, who cooperated in the surgery, added:

We have been halting mandibular growth in some of our cleft lip and palate patients if and when cephalometric studies show that their mandibles have already reached adult size, and that they are heading for an absolute, as well as a relative mandibular prognathism.

This has proved to be a very simple and effective way of forestalling gross malocclusion, and particularly for avoiding the traumatic effects of disfigurement during adolescence.

**HORIZONTAL OSTEOTOMY OF THE ASCENDING RAMUS**

In 1907 Vilray P. Blair of St. Louis first described division of the ramus of the mandible and shifting of the body of the bone backward. Blair, as evidenced by the many surgical innovations noted throughout *Cleft Craft*, was one of the pioneering geniuses of plastic surgery. He enjoyed the fringe benefits of genius, paying little attention to material things as long as they served their purpose, carrying out everyday necessities with varying degrees of rapidity while thinking of more important things and not always concerned with technique per se. A few lines from a 1972 letter from Blair's talented artist, Gertrude Hance, which accompanied her portrait of him, are pertinent:

Dr. Blair was driving a very old, dilapidated Pierce Arrow, faded to what I called pink. We went to Jefferson Barracks several times a week and he was the world's worst driver.

In 1913 and 1915, Blair reported more on his horizontal osteotomy of the mandibular ramus, carried out percutaneously with a Gigli saw. A Blair needle was passed anteriorly from the
posteromedial border on the medial surface of the mandible and out through the soft tissues of the cheek anterior to the mandible. The Gigli wire saw was passed through and the ramus sectioned horizontally between the inferior alveolar foramen and the notch, allowing the body to be moved posteriorly.

As early as 1909, W. Wayne Babcock of Philadelphia noted:

An ingenious method has been suggested by Dr. V. P. Blair, who makes a vertical incision one half inch in length posterior to the ramus, through which a heavy needle is passed into the incision behind the ramus, and then brought out through the cheek. By means of the needle, a Gigli saw is pulled through the tissues. A small metal tube is slipped over the saw through the puncture in the cheek so as to prevent lacerations of the face, then by simply pulling the saw backward and forward the ramus is divided.

Babcock then presented his own operation, using a skin incision over the posterior border of the ramus of the jaw from zygoma to a point under and anterior to the angle of the jaw. . . . The outer fibers of the masseter muscle were separated and the external surface of the middle of the ramus exposed. With a small chisel a transverse section was then made through the ramus. The operation was repeated on the other side, and the body of the jaw then forced back, and the teeth placed in the best possible occlusion. . . . Certain of the lower teeth were wired to the upper.

In the illustrations of his osteotomy, Babcock presented an ivory or metallic button to fix the fragments. He also defended his external skin incisions as opposed to Blair's "scarless" Gigli saw osteotomy:

The Gigli saw, as used by Blair . . . is very ingenious. . . . In my operation it was my desire to see the ramus. I wished to see how the fragments looked after the reduction, and I wished to use wedges also.

In Sweden, Allan Ragnell of Stockholm, in 1938, and K. E. Hogeman of Malmö, in 1951, performed horizontal sectioning by means of a saw introduced through a postauricular incision, temporarily severing the external auditory canal in order to obtain a more adequate approach to the ramus.

In 1950 J. Barrett Brown, with Minot Fryer and J. B. Templeton, noted:
There are, however, some late deformities in patients with cleft lips and palates that show such disproportion as to appear prognathic, and to have occlusions that are not adequate for mastication. When these patients are too old, or otherwise not suited for orthodontic expansion of the upper arch, then the lower jaw can be recessed to proper proportion with the upper, so that an external balance of appearance is obtained.

He advocated the horizontal osteotomy operation Blair described in 1907, with minor refinements.

In 1954 V. H. Kazanjian of the Massachusetts Eye and Ear Infirmary, Harvard University, recommended a beveled cut with the chisel, sectioning the ramus obliquely from below through an external approach. This method increased the surface of contact between the bony fragments and decreased the tendency for separation of the fragments brought about by the pull of the lateral pterygoid muscle. The lovely drawings of this method for Converse were done by the famous artist Daisey Stilwell.

Dingman evaluated the advantages and disadvantages of the horizontal osteotomy of the ramus:

It is short and simple, no scar is involved, a good cosmetic result can be achieved, and there is no sacrifice of bone or teeth and no disturbance of the mandibular arch. The disadvantages, which may be serious, are: injuries to the facial nerve, to the internal maxillary artery with severe hemorrhage, to the parotid gland and to the mandibular nerve because of the blind approach. The failure rate is high due to lack of control of the proximal fragment. The strong pull of the lateral pterygoid and temporalis muscles may cause displacement or overriding and eventual nonunion or malunion. The thin cortical bone in this area contributes to poor healing. The strong muscles of mastication are positioned out of functional alignment, and with spasm, there is shortening and overriding of the fragments. With the molar teeth in occlusion, the resulting Class One lever forces the anterior teeth
into an open-bite position. These muscles are so powerful that the anterior teeth may be extruded from the maxilla or mandible regardless of the type of appliance or intermaxillary fixation used.

**OBLIQUE SUBCONDYLAR OSTEOTOMY**

In 1967 Edward C. Hinds and W. Girotti of Houston, Texas, advocated the oblique subcondylar osteotomy of the mandible through an external incision. They have had good results over a large series. Also in 1967, M. Robinson, simultaneously with Hinds, published a similar method of extraoral section of the ramus from a point behind the gonial angle to the sigmoid notch. The chief advantage of these procedures was simplicity, which has been responsible for much popularity of the principle.

Hinds and I have been friends since my residency days in Houston in 1951. He has continued his work in the Dental Branch of the Texas Medical Center, and his only true escape from jaws has been his snowmobile in northern Minnesota. I wrote him for an example of a cleft palate case in which he had used his oblique subcondylar osteotomy. He kindly forwarded this case, noting:

This young lady was a 15-year-old Latin American with a history of operated cleft lip and cleft palate. She was wearing a maxillary plumper to hold the upper lip out. A bilateral subcondylar osteotomy was performed on March 12, 1962. No direct wiring of the fragments was performed in accordance with my policy in management of prognathism by this procedure. In most
other osteotomies I do use direct wiring. We felt that setting the mandible back would give her much more acceptable facial appearance and certainly better oral hygiene. At that time, as you know, we were not involved in maxillary surgery to any significant degree.

In 1961 in Plastic and Reconstructive Surgery, Nicholas G. Georgiade, with Galen W. Quinn, of Duke University evaluated the reported satisfactory results of Hinds and Robinson, with variations of vertical osteotomies through the ramus of the mandible, and then modified the procedure, commenting:

The use of a vertical osteotomy that extends from the coronoid notch down to the angle of the mandible, rather than a short osteotomy high on the condylar area, we feel, has many advantages and practically none of the disadvantages of the older procedures. . . . Splinting of the bony fragments after section of the muscles of mastication, we feel, aids considerably in their eventual rapid healing of the osteotomy sites. Treatment postoperatively by means of intermaxillary wiring and fixation is all that has been found to be necessary for satisfactory stabilization of the mandible.

One of their representative cases was a patient with a severe maxillomandibular disproportion due to cleft palate and associated retardation of maxillary growth. The modified sliding angular ramus osteotomy improved the relationships. They noted the importance of preoperative cephalometric studies and preoperative equilibration. The advantages of their modifications are italicized. A short procedure in one stage under direct visualization through small submandibular incisions, with the line of sectioning from the coronoid notch to the angle of the mandible always proximal to the inferior alveolar nerve and vessels, avoided any damage to these structures.

J. B. Caldwell pointed out, however, that these techniques were not applicable in moderate or severe cases of prognathism because the temporalis insertion on the coronoid process prohibits retrodisplacement of the anterior fragment more than 10 to 12 mm. This difficulty may be partially overcome by transection of the coronoid process of the mandible.

Open bite, non-union or malunion, and the long period of immobilization required are disadvantages, according to Dingman.
V E R T I C A L  O S T E O T O M Y  O F  T H E  A S C E N D I N G  R A M U S

Army oral surgeon Jack B. Caldwell served at Walter Reed General Hospital in Washington, D.C., prior to transfer to Letterman General Hospital, San Francisco. While in Washington he collaborated with Gordon S. Letterman, son of the Letterman of the Army Hospital, who had trained in plastic surgery under Blair. In 1954 Caldwell and Letterman introduced vertical osteotomy of the ascending ramus. Through a submandibular incision which allowed elevation of the masseter muscle with the periosteum, the entire lateral surfaces of the ramus from the sigmoid notch to the inferior border of the mandible were exposed. The outer cortex was perforated with a dental drill and the ramus sectioned vertically from the sigmoid notch to a point 1 cm. in front of the angle of the mandible, posterior to the mandibular foramen. The coronoid process was sectioned to release the pull of the temporalis muscle. The outer cortex of the anterior fragment was removed by osteotomy with a dental bur, and the anterior fragment was placed posteriorly, residing on the medial side of the posterior fragment. The teeth were then held in occlusion with intermaxillary fixation.

In 1977 Caldwell, now of Denver, recalled the patient and circumstance that prompted the development of this method:

A young staff sergeant had been reduced to the rank of corporal within 6 months. Investigation revealed he was extremely concerned about his appearance due to acceleration in the growth of his mandible, which caused such deterioration that he was found drunk on duty. After a period of observation of the patient and the arrival of a Broadbent cephalometer along with orthodontist E. P. Suchard, a protégé of Broadbent, we came up with the idea of a vertical section in the ramus to correct this growth deformity in this patient, who had a protrusion of slightly over two centimeters with a tendency to open bite anteriorly. I had been unable to figure out how to treat him with methods known to us at that time. Faced with this dilemma, we made cut-outs of tracings of the patient’s profile and finally decided on the vertical section which has been universally adopted since then.

A M A X I L L O F A C I A L  F O U N T A I N H E A D

Out of the ruins of an old castle in the center of the Austrian town of Graz rises a tiled roof tower with a large clock. Here
families of friendly squirrels romp when not better occupied accepting nuts from visitors and cracking the shells with tooth and jaw efficiency that must inspire the entire little world of maxillofacial surgeons. Possibly coincidentally, Graz has had an impact on the reparative surgery of the jaw, having produced more than its share of ranking maxillofacial surgeons beginning with Trauner, then Obwegeser, Köle and the many others who traveled there to study.

In 1955 in *Oral Surgery, Oral Medicine and Oral Pathology*, Richard Trauner, with Obwegeser, described his L-shaped osteotomy of the ascending ramus:

To avoid any possible damage to the mandibular nerve, it is best to perform a vertical section in the frontal plane of the ramus, immediately posterior to the mandibular foramen which lies about 15 mm. in front of the posterior border. Vertically, it is situated between the upper and middle thirds of the ascending ramus; and in certain cases a little lower. . . . We prefer a rectangular osteotomy of the ramus, an inverted L with its angle facing anteriorly.

Heinrich Köle, at present of Linz and winner of the 1959 Martin Wassmund prize, while with Trauner in the Graz University Dental Clinic, noted the disadvantages of Trauner's L-method in 1965 in *Oral Surgery, Oral Medicine and Oral Pathology*:

1. The angle of the jaw remains too far forward.
2. The extraoral incision produces a scar which is especially visible in cases in which there is a deep impression of the retromandibular area.

Therefore, the esthetic results do not satisfy all demands. . . . I decided to try an ostectomy (that is, effective removal of the surplus bone) in the ascending ramus, thereby saving the angle of the jaw as far as possible.
To save the mandibular nerve and to improve the angle of the jaw, Köle performed an arched ostectomy. This method was especially indicated, he felt, in cases of extreme protrusion in which there were broad and long ascending rami and an obtuse angle of the jaw.

In 1964, in his book *Reconstructive Plastic Surgery*, John Marquis Converse, with S. L. Horowitz and D. Wood-Smith, described a simplification of vertical ostectomy which has become quite popular. Through a submandibular incision avoiding the marginal branch of the facial nerve, the ramus of the mandible was sectioned with a Stryker reciprocating saw. The medial pterygoid muscle was raised from the medial aspect of the posterior fragment, and the anterior fragment was moved posteriorly until the desired occlusal relationship existed. Excess bone in the posterior fragment was trimmed. In severe prognathism, a portion of the posterior border of the anterior fragment was resected to avoid impingement upon the mastoid bone or facial nerve. The teeth were held in fixation for six to eight weeks.

Dingman’s evaluation is of interest:

Advocates of this procedure consider its major advantages to be: a safe approach, effectiveness in severe prognathism, no intraoral contamination, arch moved as a unit without sacrifice of teeth or bone, avoidance of injury to the inferior alveolar nerve, normal temporomandibular joint relationship assured, and achievement of a good cosmetic result. Some of the same disadvantages of transverse ostectomy apply to the vertical ostectomy—that is, facial nerve injury, hemorrhage, parotid fistula, and prolonged immobilization. The muscles of mastication are thrown out of balance, and nonunion, malocclusion and open bite can occur.
SAGITTAL SPLITTING OF THE
ASCENDING RAMUS

In 1954 Karl Schuchardt of Hamburg described a short step osteotomy of the ramus that was the precursor of the true sagittal osteotomy.

The champion of the true sagittal splitting of the ascending ramus is Hugo Obwegeser of Zurich. With both dental and medical degrees, he received his early training in maxillofacial surgery with Trauner in Graz, then came to Rooksdown House to study under Gillies about 1952–1953, while I was writing the book with Sir Harold. He was a young, gentle, blond, blue-eyed Austrian, eager to learn the principles of plastic surgery and fascinated by them set out as “Ten Commandments.” It was apparent even then that Obwegeser would become a leader in his chosen field, but there was no hint he would become the dogmatic advocate of mandatory acquisition of both dental and medical degrees for all maxillofacial surgeons. Ideally he is right, for only those who have obtained a dental degree have the trained capacity to appreciate the true ecstasy of achieving a perfect occlusion of the teeth. There have been, however, notable exceptions.

Less than five years after his time with Gillies, Obwegeser, with Trauner in a 1957 Oral Surgery, Oral Medicine and Oral Pathology, presented the first true sagittal splitting of the mandibular ramus. This is his original description of the procedure:

The incision is made in the mucosa and periosteum, extending along the external oblique line. The lower end of the incision should be directed farther away from the molars toward and into the moveable tissue so as to facilitate closure. Next, the periosteum of the outer surface of the ramus is elevated. A wide-blade periosteal elevator with a deep curvature is hooked behind the posterior border just above the angle of the jaw. With the soft tissue thus kept out of the way, the bone is incised with a Lindemann burr. The cut should be carried horizontally. It should penetrate the cortical bone only. Next, the periosteum, together with the soft tissues between the mandibular notch and the lingula, is elevated medially. The contents of the mandibular canal are protected by again hooking the aforementioned periosteal elevator below the neck of the condyle. Now the bone is cut just below the mandibular notch to a depth that will leave only the lateral cortex.
intact. This cut should be about 25 mm. above the first cut. For correction of mandibular prognathism, the bone cut will have to be inclined upward and backward, whereas for correction of a mandibular retrognathia it should take a downward and backward trend. . . . Then an osteotome about 20 mm. wide is inserted and, in order to avoid damaging the contents of the mandibular canal, it is forced backward along the outer cortical plate. . . . When the osteotome is twisted, the ramus splits in two. Thus, a steplike splitting results in the sagittal plane of the ramus, with large cancellous bone surfaces facing each other. . . . By this method, three types of correction may be made. First, by retrusion of the large anterior segment, mandibular prognathism may be corrected; second, the jaw may be set forward to correct mandibular retrognathia; and third, rotating of the anterior segment will correct an open bite. . . . The next step in the procedure is fixation of the mandible by intermaxillary wiring.

In 1964 Obwegeser, concerned about damage to the skin, nerves and vessels, and the parotid gland sometimes incident to the external approach, in addition to the problems of non-union, continued to promote his sagittal splitting technique utilizing the intraoral approach. Fixation was held for six weeks. Obwegeser contended logically that the large surface contact area provided greater bony union. The obtuse angle of the jaw can be corrected, thus improving a major part of the deformity.
Dal Pont

Giorgi Dal Pont of Belluno, Italy, made a contribution in mandibular osteotomy. His basic interest in philosophy and mechanical sciences has influenced his work in stomatology. It is his feeling that in science, methods and theories often lead to blind alleys which prevent progress.

He explains his own "breakthrough":

The technique of horizontal section of the ascending ramus, developed from Blair to Obwegeser, was bound to the concept of the horizontal section. Maybe because I was facing the problem the first time, it was not difficult for me to realize at once that the optimal solution was to abandon the external horizontal section and substitute a vertical section.

In 1959 Dal Pont suggested extension of the sagittal splitting osteotomy up to the third molar region. In 1961, in the Journal of Oral Surgery, Anesthesia and Hospital Dental Service, he presented a case of cleft lip and palate before and after his retromolar osteotomy and pointed out the advantages of this approach:

1. a better and easier adaptation of the fragments; 2. broader contact surfaces; 3. greater possibility for correction of prognathism, micrognathia
and open bite; and (4) avoidance as much as possible of muscular displacement.

He noted (in b) that the masseter muscle was left on the distal fragments, whereas the internal pterygoid muscle moves together with the displaced larger fragment. In the other possibility (c), both muscles remain on the distal fragments.

Dal Pont described a sound sagittal procedure for retromolar osteotomy in which bone incision lies on a plane that starts near the edge of the linea obliqua and extends sagittally between the cortical plates from the retromolar region up to the mandibular angle. To correct the prognathism, a piece of cortical bone is removed on the buccal aspect and in the anterior border of the ascending ramus, for proper adaptation of the fragments.

Tony Wolfe points out that this procedure increases the length of bony contact but warns that it also brings the third molar into the field. If the third molar is impacted, it can be difficult to remove without fracturing the proximal fragment and may well merit preliminary extraction.

In 1966 Dal Pont charted the evolution of ramus osteotomy with simplicity.
By 1971 Obwegeser had incorporated the Dal Pont extension in his procedure. It was well illustrated in his chapter in *Cleft Lip and Palate*, where he presented the versatility of the principle.

In 1974, at the Second Congress of the European Society of Maxillo-Facial Surgery in Zurich, Walter Pipersack and Hugo Obwegeser presented long-term analysis of their results in cases of sagittal splitting. They reported a 30 percent incidence of early anesthesia of the lower lip. This technique requires a skill beyond that of some surgeons. In 1972 Stanley J. Behrman of New York reviewed 600 patients receiving the sagittal splitting procedure by 64 oral surgeons and reported such complications as regression and relapse, hemorrhage, trauma to the mandibular nerve, edema, fragmentation of the ramus, necrosis or sequestration of bone, and infection. He warned that it required great technical skill, specialized instruments and assistants, and that because of the difficulty of exposure, it was not easy to teach. Because of the excellent bony apposition and remarkable freedom of movement
of the mandible afforded by sagittal splitting, however, he concluded that it was superior, and with experience, complications would decrease.

After completing his plastic surgery training at the University of Miami, S. Anthony Wolfe went to Europe for a year of postgraduate training in craniomaxillofacial surgery. No sooner was he overseas than he discovered the three centers of excellence in “hard tissue” surgery: Paris with Tessier, Zurich with Hugo Obwegeser, Hans Peter Freihofe, and Walter Pepersack, and Nancy with Jacques Dautrey. Nancy is a city situated right in the center of the prognathism belt stretching all the way to the Hapsburgs’ Vienna and midway on the road between the other two cities.

**Dautrey**

Jacques Dautrey started as an orthodontist and stomatological surgeon with Ginestet at Foch Hospital, Paris. He and Tessier are old friends; in fact, Tessier insists his assistants and visitors drive three hours to the dreary industrial town of Nancy to see Dautrey work in his operating room on ground level at Clinique Saint-André. He limits his surgery to procedures on the maxilla, mandible and temporomandibular joint and carries out each with perfection and finesse in an atmosphere of tranquility. His two large operating room windows overlook rolling fields dotted with cows grazing peacefully.

Dautrey has done more than 500 sagittal splitting procedures of the mandibular rami and has reduced the incidence of numbed lip postoperatively to virtually zero. Patients leave the hospital two to three days after the surgery. Here is Wolfe’s outline of Dautrey’s refinements:

1. Instrumentation: All retractors used in the mouth are matte, and have outward-curved edges to avoid injury to the lips. Note also his modified Smiley osteotomes which when twisted will not crush the nerve. Fibre-optic aspirator is important for lighting, and Kerr drill with irrigating attachment prevents bone burn.

2. Ballooning of mucosa with dilute vasoconstrictor solution, and separate periosteal incision at a slight distance from the mucosal incision allows for a two-layer closure.
3. After drill holes are made through the anterior cortex, and medial and lateral cortical cuts made with a Lindemann burr, the modified Smiley osteotomy is used to hug the lateral cortical plate.

4. Ramus split delicately without using heavy instruments which crush the nerve.

5. He keeps the condyle seated in the glenoid fossa (which must be done to prevent postoperative anterior open-bite) by several tricks:
   a. Before the osteotomy, he scores a vertical line, beginning on the maxilla behind the last molar, and running down on the lateral surface of the mandible. These marks on the maxilla and condylar fragment of the mandible are made with the teeth in their initial occlusion and should line up at the end of the operation.
   b. Another method is to push the condylar fragment forcefully back against the posterior wall of the glenoid fossa, compressing the capsular cartilage, then allow it to come forward 2–3 mm. before trimming the excess bone from the distal portion of the condylar fragment. The two fragments would then fit exactly and are held together by a fine wire through the lateral cortices.

A final refinement developed in 1977 by Dautrey is the keeping of a small spur on the proximal fragment which fits into a pocket in the distal fragment, giving further stability by autocontention.

In 1976, in *New Concepts in Maxillofacial Bone Surgery*, Bernd Spiessl of the University of Basel, Switzerland, described a touch of finesse he adds to the method by permanently fixing the two sagittally split fragments with three lag screws which can be inserted percutaneously through small stab wounds. The advantages claimed by Spiessl included a guaranteed position of the fragments, early mobilization and a shorter period of intermaxillary fixation.

In 1965 C. C. Knowles analyzed the remarkable change in facial contour after osteoplastic procedures on the mandible in cases of relative prognathism. It is his belief that preoperatively many of these patients have shortness and eversion of the upper lip and absence of the rolled outline of the vermilion border of the lower lip. Their appearance postoperatively gives the impression that the upper lip has been lengthened and has lost its eversion while the lower lip, previously undefined, now has a natural fullness. Knowles contends that this improvement is due
to an alteration of the muscles of facial expression, particularly the depressor anguli oris inserting into the mouth. The origin of the muscle from the lower border of the mandible tends to pull the mouth downward as the mandible is moved back. The backward movement of the risorius and platysma transmitted to the orbicularis may be responsible for the improvement in the lower lip roll.

Mandibular Retrognathism

According to Dingman in his section in *Cleft Lip and Palate*, edited by Grabb, Rosenstein and Bzoch:

Eighty to 90 percent of children born with the Pierre Robin syndrome (glossoptosis and micrognathia) have clefts of the soft palate or soft and posterior hard palate [B. E. Bromberg, R. Pasternak, R. W. Walden, and L. R. Rubin, 1961; W. S. Kiskadden and S. R. Dietrich, 1953]. The growth potential of the micrognathic mandible is inconsistent; while normal growth is eventually seen in most of these patients [S. Pruzansky and J. B. Richmond, 1954; B. Douglas, 1956], a significant number of them will fail to reach full mandibular growth and have a retrodisplaced mandible with Angle Class II malocclusion. If occlusal abnormalities are minimal or orthodontically correctable, facial contour can be improved with onlay chin implants of autogenous bone or cartilage, irradiated cartilage, synthetic materials, or horizontal advancement osteotomy of the mandible below the apices of the teeth. For severer degrees of retrodisplacement, a step osteotomy through the molar region, with advancement of the anterior fragment and insertion of a bone graft, has been our choice of treatment. This operation can be carried out in the teens any time after mandibular growth has ceased.

According to Converse, oblique vertical section of the ramus was described by A. A. Limberg of Leningrad in 1925 in the treatment of micrognathia with open bite (A and B). Later, in 1928, Limberg proposed the addition of a costal bone graft for the micrognathia. In 1927 Wassmund described a vertical section with a forward angulation above the lingula, extending through the base of the coronoid process.

In 1936 and 1942 O. Hofer described a method of correcting anterior alveolar retrusion in the normal mandible by advancing the entire alveolar fragment. In 1959 H. Köle modified the
In 1948, in *Plastic and Reconstructive Surgery*, Reed Dingman presented his favorable step osteotomy for correction of mandibular retrusion in a two-stage procedure, with the first stage a single vertical cut above, at the point of lengthening. Two weeks later, through a skin incision 1 cm. below the inferior border of the mandible, a vertical cut well forward of the initial cut, and a horizontal cut below the inferior mandibular nerve joining the vertical cuts, produced a step osteotomy which allowed forward advancement of the mandible. Dingman noted that advancement of the mandible 1 cm. was possible without tearing the nerve. Bone wires and intermaxillary fixation were used.

In 1948 Pichler and Richard Trauner of Austria described a step-like osteotomy of the body to bring the mandible forward in microgenia.
In 1957 Trauner, again with Obwegeser, readvocated his cartilage graft of 1955:

For mild forms of mandibular prognathism I prefer the retrocondylar cartilage implantation because it is a minor surgical intervention which does not require a postoperative intermaxillary wire fixation. . . . Between the anterior wall of the auditory meatus and the glenoid fossa lies a bone suture, the fissura petrotympanica. Just before and above it, the bone is perforated with a small drill. The piece of cartilage is tied to the bone with wires going through this hole. The cartilage is situated close to the anterior wall of the bony auditory meatus.

In 1957 Hugo Obwegeser called attention to the fact that his sagittal splitting osteotomy of the mandibular ramus was also applicable to the correction of retrognathia.

In 1958 Karl Schuchardt of Hamburg utilized this type of osteotomy and inserted an L-shaped bone graft for the elongation of the mandible in micrognathia.

In 1976 Herbert Mehnert of the University of Innsbruck, Austria, presented his variation of the vertical osteotomy of the mandibular rami for retrognathism. He explained:

(a) After forward movement of the mandible to an Angle class I occlusion, the ramus is vertically osteotomised. (b) The condyle-bearing segment can then be replaced in the glenoid fossa. (c) Creation of a step with a bur to wedge in the condylar segment, so that the mandible does not slide back into distoclusion.
In 1977 Broadbent and Woolf of Utah reported 26 cases using the Obwegeser-Dal Pont sagittal split osteotomy for retrognathia. They noted that complications, especially relapse, weakness of the lower lip and numbness of the lower lip, were common enough to encourage them to look for another surgical approach with less morbidity, possibly the methods of Hinds, Trauner or Mehnert.

In our Rag Bag chapter in Gillies’ and my Principles and Art of Plastic Surgery, a case of Treacher Collins syndrome presented a mandible of abnormal vertical length with a receding chin. An advancement osteotomy pivoted on a Gillies periosteal hinge was beneficial.

Method: An osteoplastic flap was cut from the lower margin of the mandible, leaving the periosteum along its upper border. This large block of bone could then be folded over to rest in front of the mandible to give the necessary prominence and contour.

Along the same principle but as a free graft rather than a flap, Obwegeser, advanced a V-shaped segment of inferior mandible to increase the mentum projection. By minor ostectomy or osteotomy of the anterior angle, he regulated the shape of the advancing arch.

Finally, here is Tony Wolfe’s modification of mandibular advancement for receding chin in a 35-year-old schoolteacher with a bilateral cleft lip and Crouzon’s disease. Extensive ortho-
dontic treatment gave her "satisfactory" occlusion, but she was left with considerable facial disharmony.

As Wolfe noted:

It would have been vastly preferable not to have had the preliminary orthodontics, so that a Le Fort III osteotomy alone would have corrected all the problems at once. Now if a Le Fort III advancement were done to correct the exorbitism and maxillary hypoplasia, she would end up with a Class II malocclusion, and either reverse orthodontics postoperatively or a simultaneous Le Fort I would be needed to maintain her present occlusion. The patient declined these two possibilities, so an orbital expansion, onlay bonegrafting to the anterior maxilla, and modified sliding advancement of the mandibular symphysis, retaining muscular attachments, were performed. She also had an Abbé flap and a corrective rhinoplasty.
BIFID MANDIBLE

This patient was born with a cleft of the lower lip involving the vermilion, a submucous cleft of the orbicularis muscle, a frenulum of the tongue attached in the cleft alveolus and a bifid mandible. At 5 months of age the tongue was detached and the lip cleft closed with muscle approximation, leaving a skin dimple (Volume II, P. 814).

At 8 years of age the bifid mandible revealed an instability exaggerated by masseter muscle contractures which could separate the mandibular segments 0.5 cm. At surgery the mandibular symphysis was exposed through a lower labial sulcus incision leaving a proximal mucosal flap for closure. The mental nerves were visualized somewhat lateral to their usual location. S. A. Wolfe harvested a portion of the right 6th rib and stabilized the cleft in this manner:

The midline cleft of the mandible was dissected free of soft tissue attachments and several millimeters of sclerotic bone on either side were removed with a burr. An appropriate segment of rib was fashioned to fit in the diastasis and was fixed with two #40 wires. The remaining rib was split in two and overlaid the anterior mandible across the cleft and wired. One

Hemovac® was used for drainage and the wound closed in layers. Four circummandibular wires were passed and used to fix a previously fabricated Vitallium splint (Berkowitz).

An uneventful recovery was followed by removal of the splint and circummandibular wires after 8 weeks.
MODERN maxillary surgery has become an important part of secondary rehabilitation of the cleft lip and palate deformity, and it all began when a brilliant and curious Frenchman started hammering on cadaver skulls to see where they fractured.

René Le Fort of the University of Lille, France, served for years as a military surgeon at Val de Grâce Hospital in Paris. In 1901 he published the results of his cadaver experiments, which followed the principles of the scientific method laid down 50 years before by Claude Bernard. His work involved positioning cadaver heads, striking them with a piano leg, and then, by dissection, discovering the extent and type of the maxillary fracture. Here are some of his notes, as translated by Tessier:

The upper jaw, despite its multiple connections to the base of the skull, enjoys a considerable independence from it. . . . A great number of weak points (or better said, lineae minoris resistentiae) cause the facial bones to break into fragments so that the stress is exhausted by the effect produced, preserving the integrity of the bony envelope of the brain.

His first great weak line, or Le Fort III fracture, passed through the nasal bones, cribriform plate, upper part of the frontal process of the maxilla, upper part of the lacrimal bone, medial walls of the orbit, into the intraorbital fissures, across the orbital floors into the sphenoid and even frontal bones, and down across the base of the pterygoid processes. His second great weak line, or Le Fort II fracture, crossed the lower part of the nasal bones, frontal processes of the maxilla, lacrimal bones at the nasolacrimal canals, infraorbital rims at the junction of the malar bone and the maxilla, through the infraorbital foramen, around the malar bone
respecting it, across the upper nasal septum, into the pterygo-maxillary fissures, and across the base of the pterygoid processes. The third weak line, or Le Fort I or Guérin’s fracture (1866), started from the lower part of the pyriform aperture, crossed the canine fossa below the malar bones, rising posteriorly to cross the pterygomaxillary fissure, and cut the pterygoid process. He acknowledged:

This third line is the one involved in Guerin’s fracture, one of the most frequent forms of upper jaw fracture.

**USE OF LE FORT I IN TREATMENT**

Martin Wassmund of the Rudolf Virchow Hospital, Berlin, was the first to create a Le Fort I fracture for treatment purposes. Wassmund, the son of a preacher and a fiery, temperamental surgeon with degrees in dentistry and medicine, would go into battle at the drop of a glove to defend his methods. During World War II he was a chief of the Military Hospital for Maxillo-Facial Surgery, and over the years he carried out a phenomenal amount of maxillary, mandibular and palatal surgery. His favorite adversary was Axhausen. As early as 1927, he was the first to perform an osteotomy and repositioning of the entire maxilla in a case of anterior open bite. His osteotomy was performed along the lines of a Le Fort I fracture, extending completely across the maxilla and including the pterygoid plates of the sphenoid.

In 1934 Axhausen used elastic traction postoperatively to pull the maxilla forward into the desired position. In 1942 Karl Schuchardt was the first to suggest sectioning of the maxilla in the pterygomaxillary groove, thereby leaving the pterygoid plates intact.

**FORWARD MOVEMENT OF THE MAXILLA THROUGH LE FORT I OSTEOTOMY**

In 1952, Gillies and I wrote of Gillies’ planned Le Fort I osteotomy:
When a mandible has been retroposed following osteotomy, the pouting lower lip can be nicely tucked in behind the upper. Yet the harelip-cleft palate deformity is merely a relative prognathism of the lower jaw because of a true agenesis of the upper. For this reason protrusion of the maxilla by osteotomy would seem a more direct approach. Confidence in this technique has been developed through familiarity in dealing with floating fractured maxillae.

It is now freely admitted that the stresses laid on the maxillary arch by the early surgery of palate and lip lead to gross maldevelopment and agenesis of the maxilla and its teeth. We here follow the principle of "replacing normal into normal position," and in the maxilla, therefore, we very much favour the bold osteotomy of the tooth-bearing segment. The fragments can now be held in predesigned positions to give maximal function and appearance.

The example case was Joyce, who had had nine operations for a bilateral cleft lip and palate, including three attempts at palate closure. The maxilla was contracted and the cleft still present, with the soft tissue remnants so tiny that even a Gillies-Fry procedure was not planned. An upper buccal inlay and nasal correction improved the lip and nose moderately, and the patient was able to speak more or less intelligibly with the aid of a huge obturator. Being a girl of great determination, Joyce was dissatisfied and eager to have maximum treatment. The plan was to correct the distorted maxilla and replace her obturator with a tube pedicle. The Rooksdoun House chief of oral surgery, dynamic Norman Rowe, made dental models and the necessary splints and planned the fixation. Then, with his co-author H. C. Killey, Rowe made demonstration models which Gillies and I used in The Principles and Art of Plastic Surgery to show osteotomy and bone grafting of the deficient cleft palate maxilla. This was our description:

The upper buccal sulcus is incised, the mucoperiosteum reflected and nasal saw cuts are made in the maxilla on a line above the apices of the teeth. It is not always possible to avoid opening into the antrum, but when this occurs it does no harm. Remember that the principal blood supply of each maxilla following osteotomy is derived from the greater palatine artery, and preservation of this artery is essential. Therefore no attempt is made to divide the tuberosity with the saw. The final sectioning is achieved by inserting the chisel into the distal end of the saw cut, and after a few cautious taps the maxilla is levered downwards and outwards until the
remaining bony attachment of the tuberosity is fractured in a greenstick manner. It may also be necessary to pry open the original hard palate cleft before the segment is free enough to go into satisfactory occlusion with the corresponding lower teeth. The gum may go blue but the circulation has been found quite adequate. The casual hospital onlooker is often impressed by the fact that the patient suddenly takes on a more normal contour. The two maxillae are now fixed by plates and bar in the position they might have taken had their development been normal.

Care must be taken to relate the occlusion to the mandible and to the cranial base. Cancellous chips from the ilium are packed into the hinge, but a strong one tapped into the apex of the bone cut serves as the main wedge to keep the new position. Others are added to consolidate. . .

Initially it was feared that the bone graft, being exposed to the nasal cavity or possibly the antrum, might become infected. Experience has shown that this is not the case, for to date no graft has failed to achieve bony union. The integrity of the graft is probably preserved by the excellent blood supply, which is derived from the adjacent bone and muco-periosteal covering—the mucosal closure should be meticulously performed.

The sparks of Gillies’ original work in osteotomies of old facial fractures and forward positioning of the maxilla in cleft cases, as well as his osteotomy design for correction of the oxycephaly of Crouzon’s disease, kindled Tessier’s interest in the new field of craniofacial surgery. Indeed, Tessier made many visits across the Channel to observe the work of Sir Harold Gillies.

It is now well recognized that the forward movement of the maxilla is much more frequently indicated to correct the prognathic appearance in cleft patients than retropositioning of the mandible. Gillies spearheaded the early work in this shift in clefts, as already described.
John Converse has been interested in forward advancement of the maxilla. In 1952 in *Plastic and Reconstructive Surgery* J. M. Converse and H. Shapiro described advancement of the maldeveloped maxilla with malocclusion (A). Their line of osteotomies extended from the pyriform aperture to the maxillary tuberosity on each side (B), crossing the hard palate (C), through the septum at the level of the nasal floor (D). Advancement of the maxilla reestablished dental occlusion (E, F). The illustrations by Stilwell were explicit.

By 1971, Obwegeser and his co-workers had carried out the Le Fort I osteotomy in over 100 cases, and it had become routine. Here are the steps in his approach: (1) vestibular mucoperiosteal incision from one infrrazygomatic crest to the other; (2) osteotomy of anterior wall of the maxilla and lateral wall of the nose, and separation of the nasal septum from the hard palate; (3) mucoperiosteum on the palate not elevated, transverse bone cut on the palate (Converse, 1952; Köle, 1965), and cutting the pterygoid plate avoided; (4) separation achieved with a heavy osteotome at the pterygomaxillary fissure; (5) tilting of maxilla forward with fingertip, fracturing the posterior part of the lateral wall of the nose and the posterior wall of the maxillary sinus; (6)
forward movement of maxilla facilitated by incision of soft tissue scarring.

Intermaxillary fixation with skeletal suspension, either circumzygomatic or percutaneous by wire to headcap or to pins in the frontal bone, is used, but direct wiring between osteotomy lines has been satisfactory in some cases.

In 1969 Obwegeser stressed the importance of placing bone blocks in the interpterygomaxillary space (IPM), wedged between the buttress of an intact pterygoid plate and the tuberosity to maintain the advanced position of the maxilla. In 1971 he readvocated insertion of this bone block, noting:

Failure to do so permits the scar tissue to contract and pull the maxilla backward.

He also recommended the insertion of bone where there is insufficient bony contact along the path of the anterior maxillary osteotomy. In spite of exposure these medullary bone grafts survive, as noted by Gillies and others. To correct any flatness in the areas of the infraorbital rims, subperiosteal bone onlays are inserted.

Here is a unilateral cleft case with retromaxillism and a humped nose that was corrected by Obwegeser, as shown in preceding diagrams (A, B and C) and partially presented in Cleft Lip and Palate with his technique of advancement in two sections. Models show preoperative occlusion and model operation for accurate planning (D).
Occlusal views are shown of preoperative (E), postoperative (F) and final dental bridge work by patient’s dentist (G).

Cephalometric x-ray films show preoperative condition and result four months postoperative with huge retromaxillary bone graft still visible. The before and after profiles show correction of the humped nose by forward movement of the maxilla only, without nasal surgery.

Tenacious Joseph E. Murray of the Peter Bent Brigham Hospital and Boston Children’s Medical Center, the premier pioneer in kidney transplantation, has also been fascinated by craniofacial deformities. He fashions his plan of treatment according to the patient’s desires and enjoys shifting and shaping bones. Once in the Brigham operating room while visiting as a Monks Lecturer, I watched Murray tailoring an iliac graft. He glanced up with a twinkle in his eyes.

Imagine getting paid for doing something as much fun as this!

Murray is challenged by deformities of the skull and facial skeleton as much as by the bleak face of a bad mountain. Whether on a wedge ascent of a chimney in the Alps or on the treacherous Nepal footpaths leading to Tibet high over the Kali Ghandaki River running in the deepest gorge on earth, he faces each crisis with conditioning, caution and courage. He warns:

While wondering about the next hand, foot or rope hold there is danger; doubt is dangerous. Decisiveness in decision is followed by decisiveness in action and a secondary decision can be just as vital. . . . After a very difficult
traverse half way up Mt. Darwin in the Sierras we were trapped in a cul-de-sac with no escape. Here admission of our fault and retracing the tough traverse to a better alternative route was chosen over chancing an improper, unplanned new route.

In 1977 Murray forwarded a secondary cleft case in which Robert Gross had closed the lip in the early 40's. The patient had been lost to follow-up for 20 years.

In November 1972, Murray, with Paul Tessier assisting during his first operative visit to Boston, carried out a mandibular setback (Obwegeser ramusotomy), maxillary advancement (Le Fort I) and onlay bone graft to the maxilla.

Murray reported:

bilateral paresthesia in mental areas, realignment of maxillary dentition and fixed prosthesis and excellent psychosocial rehabilitation. The patient married one of the nurses caring for him and now has a child and a successful real estate business.
Ian R. Munro of Toronto trained at Cambridge University and St. Thomas’s Hospital, London, and took his postgraduate study at the University of Toronto, where, as a resident at the Hospital for Sick Children, his interest in craniofacial deformities was first stimulated. From 1971 to 1974 he peregrinated between Tessier and Obwegeser, and now returns regularly for further observation. He always has classical music playing in his operating room, with his best work created during Wagner. Here are two of his secondary cases corrected by Le Fort I osteotomies:


The blood supply to the maxilla during these advancements can become somewhat impaired. Gillies noted this situation, as has Obwegeser, who warned:

Often [gingival and palatal tissues] appear cyanotic during surgery, and, therefore, the suturing must be meticulous and the tissues handled with the utmost gentleness. The true fate of the palatal blood vessels is not known, but in a forward movement of up to 20 mm. it is improbable that they still function. However, in my experience, I have not seen necrosis of a bony segment.

Intermaxillary fixation is maintained for four to six weeks, and for two or three weeks after release of fixation forced opening exercises may be necessary. The first signs of a possible relapse will already be apparent during this period.

A WARNING

It has been noted that in patients in whom cleft palate surgery has included ligation of the greater palatine vessels, partial maxillary necrosis can occur when major maxillary advancement (2 cm.) is carried out subsequently. In 1979 Rainer Drommer of Gottingen, Germany, with Obwegeser studied 12 cleft palate patients being considered for Le Fort I osteotomies, using external carotid arteriography to show presence or absence of vessels. All but 1 of the 12 revealed the descending palatine artery and its branches to be intact. In the one exception a Le Fort III osteotomy was used. They concluded that in the absence of the greater palatine vessels, Le Fort II or III osteotomies, in preference to Le Fort I, may be indicated for a safer advancement since these more radical procedures at least preserve the needed anterior vestibular blood supply.

Multilingual Stephen Anthony Wolfe of the University of Miami, as the son of a military attaché (a legitimized spy), spent his childhood in Russia, France and Switzerland. As a Harvard medical student, during a visit to a state institution for the mentally retarded, he saw several patients with acrocephalosyndactyly (Apert’s syndrome) with near normal intelligence. He
learned that one of these patients, with the usual grotesque and monstrous facial appearance, had had to take the institution entrance exam three times to get a low enough I.Q. test score to qualify for admittance and relegation to a hiding place. While a surgical resident at Boston’s Peter Bent Brigham Hospital, Wolfe came upon Paul Tessier’s first corrective craniofacial publication including Apert’s disease, in the Annales de Chirurgie Plastique. In 1968 he saw Tessier give a presentation in Montreal. After completion of a plastic surgery residency at the University of Miami, Wolfe went to Europe to study for a year at the hard tissue centers of excellence, working primarily with Tessier in Paris, but also visiting Obwegeser in Zurich. Wolfe was impressed with the importance of Obwegeser’s IPM bone grafts. He noted:

In the Le Fort I osteotomy, these IPM bone grafts are more crucial than in the Le Fort II or III osteotomies, since only in the IPM space and across the anterior maxillary osteotomy lines are bone grafts put to maintain position against subsequent soft tissue pressures. In the Le Fort I osteotomy, even if there is good intercuspation of the teeth in their new position, intermaxillary fixation for six weeks is necessary. If there is not good intercuspation, an overcorrection of 2–3 mm. should be done.

Wolfe outlines his Le Fort I osteotomy:

1. Nasal intubation, with tube sutured to septum.
2. Infiltration of alveolar mucosa with 1:400,000 epinephrine high near upper buccal sulcus to facilitate later closure.
3. Mucosal incision stops near the first molar and further dissection into pterygomaxillary space done by tunneling to permit later closure.
4. Mucosa dissected free from pyriform aperture and septum. In cleft cases, a more thorough dissection of the nasal floor in the cleft side is necessary.
5. Medial anterior maxillary cut well above pyriform aperture (“Le Fort 1½”) and slightly up on beginnings of malar prominence to avoid tooth roots.
6. Pterygomaxillary disjunction done gently with butt of hand on a sharp, curved osteotome. The pterygoid venous plexus may bleed vigorously, but generally this can be controlled with packing. Reoperative surgery in this area can be particularly bloody.
7. The septum is cut submucosally with a guarded osteotome.
8. At this point, firm downward pressure on the maxillary alveolus will open up a gap in the maxilla through which the medial and posterior walls of the maxillary sinus can be cut under direct vision.

9. The Rowe forceps, or Tessier “de-Crouzonizing” grapnels achieve a completely free maxilla which can be brought into the desired occlusion.

10. Bone grafts placed in the IPM space if there has been an advancement of more than 2 to 3 mm., and wired along the anterior maxillary cut. Fresh iliac cancellous bone is preferred to all other materials. In cleft cases there is often a differential movement of the two segments. Bone grafting of the nasal floor on the cleft side gives bony continuity to the palate, which can be continued anteriorly to close the alveolar arch.

11. Suspension and immobilization with circumzygomatic wires. If there is any mobility at the maxillary osteotomy line, further stability can be obtained with a wire passed percutaneously around a screw in the glabellar region (Kutner suspension).

12. Nasogastric tube passed at end of the case.

13. Intermaxillary fixation 6-7 weeks.

Here is a girl born with a unilateral cleft of the lip and palate, treated in infancy in South America, who developed a retro-maxillism which, in turn, was treated by another service with a Le Fort I osteotomy at the age of 11 years with apparent correction of occlusion. When seen at age 15 years, she revealed a moderately severe class III malocclusion requiring a 10 mm. advancement. This postoperative relapse is a common occurrence in cleft cases, but it was exaggerated by continued growth of the mandible while the osteotomized, bone-grafted maxilla remained stationary.

Tony Wolfe, with the assistance of orthodontist Sam Berkowitz, undertook maxillary correction. He noted:

Re-doing a Le Fort I osteotomy is not as easy as the original operation. When a bone graft has been placed in the pterygomaxilllary space, the pterygoid venous plexus becomes adherent to the bone graft and considerable bleeding can occur during dissection of the soft tissues from the bone. This occurred in this case during the pterygomaxillary disjunction but fortunately was controlled with patience and by packing with Surgicel. This bleeding can be far more serious, and indeed deaths from sanguination at this stage in a Le Fort I osteotomy have occurred (D. Wood-Smith verbally reported one at the Duke Cleft Palate Symposium in 1973). Therefore, one
should wait until mandibular growth is complete before advancing the maxilla.

This timing of maxillary surgery pertains to other craniofacial procedures. Those advocating early maxillary advancements in the first half of the first decade of life for Crouzon’s and Apert’s syndromes to “spare these poor little children and their parents any psychological stress” will markedly increase risks when reoperation becomes necessary.

After osteotomy

Nine months after maxillary advancement and correction of malocclusion, I performed a cleft lip rhinoplasty including nasal reduction, alar cartilage lift and overlap, septal cartilage struts into columella and alar base advancements (Volume I). Three months later the alar rim was revised and upper lip scar excised with transposition of a narrow vertical flap from center of lip to lengthen the short left side. A shield-shaped Abbe flap was transposed into the defect.
In cleft palate patients, once the Le Fort I has been performed, the two halves of the maxilla will be independently mobile. Transverse palatal expansion can be achieved and maintained by bone grafts in the cleft space.

Excellent occlusion by a skilled but overenthusiastic orthodontist can prevent the best treatment and force second-rate onlay grafting. S. A. Wolfe considers this a frequent and frustrating situation, one of the greatest crosses the maxillofacial surgeon is being forced to bear. He noted:

Orthodontists who do not work closely with a surgeon can fall into the trap of treating skeletal deformities with orthodontics. In essence, they burn the bridge for a monobloc advancement. This patient had maxillary hypoplasia and class III malocclusion, but underwent extraction of teeth and orthodontic therapy instead of a Le Fort I. Onlay bone grafting gave considerable improvement, but was clearly the procedure of second choice.

She later had some nasal correction and a midline, shield-shaped Abbe flap.

In 1977 Hans Freihofer of Zurich emphasized the wisdom of waiting to do bone surgery:

Based on the experience of 100 cases, I would strongly suggest that before performing orthodontic surgery, one should wait until growth is completed. This applies especially to Le Fort I osteotomies so important for many cleft patients. The comparison between non-cleft and cleft cases has shown that the results in young non-cleft patients are very bad whereas the results in cleft patients are even worse. Among patients being operated below the age of 16, there are 71% non-acceptable results, and among patients being
operated between 16 and 17 years, the percentage was 27%. In non-cleft patients the respective figures are 29% and 12%.

Of course, this is very bad news for cleft patients because, according to our philosophy, “first the bone and then the soft tissues.” This means that secondary corrections can only be undertaken very late and often cannot be terminated at the age of 20.

**NASAL CHANGES WITH LE FORT I MAXILLARY ADVANCEMENT**

In 1977 in the *Journal of Maxillofacial Surgery* Hans Peter M. Freihofer, Jr., of Zurich elaborated on the nasal effect of maxillary advancement first noted by Obwegeser:

Based on 25 cases with unilateral clefts of lip, alveolus and palate with retromaxillism (CLAP) and 25 cases with pure retromaxillism (RM) the effect on the nose of advancing the maxilla by a Le Fort I osteotomy is analyzed. It can be shown that on average the base of the nose which is at the same time the base of the upper lip, follows the base of the maxilla in a ratio of 4:7 while the nasal tip is advanced in a ratio of 2:7. This means that to achieve a specified advancement of the nasal base, the maxilla has to be brought forward about twice this amount. A planned advancement of the tip of the nose can, on average, only be obtained by an advancement of the maxilla by three times this amount. The tangent to the columella is tilted considerably forwards and upwards. The movement is a little more marked in CLAP than in RM. . . . Leaving the nasal spine intact and tilting the maxilla forwards and upwards have a favourable influence on the advancement of the nasal tip. . . . On the other hand, if the nasal profile is required to stay unchanged as far as possible, the nasal spine should be removed and the maxilla should rather be tilted downward.

**FORWARD MOVEMENT OF THE MAXILLA WITH LE FORT I AND OPENING THE CLEFT**

Forward advancement of the maxilla while simultaneously opening the cleft is most often used in unilateral complete clefts, combining the techniques of rotation and advancement of the maxillary segments. Obwegeser has been a pioneer in this maneuvering.
Here is an interesting segmental Le Fort I osteotomy by S. A. Wolfe, who refers to this type of Le Fort I as a "Le Fort ½ plus ½." The patient was born with a unilateral cleft lip and palate. A LeMesurier closure of the lip and a von Langenbeck palate procedure had been carried out in Alabama. I did some lip and nose revisions at age 6 years and a cleft lip rhinoplasty at 16. Subsequently, the patient's orthodontist wrote from Georgia stating that he was unable to obtain a satisfactory occlusion and that an oral surgeon had recommended a mandibular setback. Tony Wolfe was consulted and this is his report:

The patient's soft tissue result was reasonable and the profile acceptable but there was still moderate flatness of the midface. Analysis of the dental models showed class III malocclusion at the molar level of both of the maxillary segments, but with a left segment which was also in crossbite, and anteriorly had an open bite of 13 mm. Thus, the left maxillary segment was making very little contact with the mandible, and was almost useless to the patient for mastication. There is no way that moving the mandible back would correct this. It would only give a better occlusal relationship to the teeth of the right side and would do nothing for the flatness of the patient's midface.

Before osteotomies

**Operation:** Anterior maxillae sectioned well above the level of the pyriform aperture. On the left, there was no pyriform aperture since the bony cleft extended into the nasal floor. A large oronasal fistula present on the left, running up through the cleft alveolus. Careful sectioning of bone connections between pterygoid plates and maxillary tuberosities. Nasal septum and vomer cut from palate (attached on right only). Fracture of medial and posterior walls of maxillae then produced by firm posterior pressure. Maxillary osteotomy line then opened up with distraction forceps, and remaining
small bony connections, clearly visible through the now-opened maxillary sinus, sectioned with a small osteotome. Both greater palatine vessels clearly seen from above, through the sinus. Soft tissue stretching carried out with Rowe forceps and Tessier grapnels until both maxillary segments could easily be moved beyond their intended positions with only slight traction from a tissue forceps. The right segment was moved 6 mm anteriorly and 2 mm laterally. The left segment was brought forward 8 mm, laterally 4 mm, and rotated inferiorly 13 mm. Circumzygomatic suspension attached to the circummandibular wires to avoid excessive traction on teeth, and intermaxillary fixation obtained. Nasal lining had been separated from the palate the entire length of the palatal cleft on the left, and this was closed. Cancellous iliac bone used to fill the palatal cleft, rebuild a nostril floor and pyriform aperture on the left, and close the alveolar cleft. Corticocancellous chunks placed in pterygomaxillary spaces. The oronasal fistula was easily closed.

Intermaxillary fixation was maintained six weeks and dental models obtained to show the results clearly. Such a result could have been obtained only by very great difficulty and extensive postoperative orthodontics if the mandible had been set back and the cleft bone grafted, as suggested, and he still would have had a flat face.
In the bilateral cleft, forward advancement of the maxilla, while opening the cleft, poses a danger because the blood supply to the premaxilla enters only through the vestibular mucosa. Obwegeser advised:

In the first operation the lateral alveolar segments only are advanced; in the second operation, when the re-opened cleft is being closed, I advance the premaxilla and do a simultaneous bone implantation.

Jacques Dautrey of Nancy has added a modification. For cleft lip and palate cases he no longer does a complete Le Fort I, having noted that the second superior molar almost always occupies the normal position. He therefore performs a unilateral segmental osteotomy which mobilizes the incisors, if present, and the canine, the two premolars and the first molar. The positioning of this limited segment is much easier and is satisfactorily immobilized with a simple arch bar (without the use of intermaxillary fixation) since the second molar of one side and the entire hemi-arch of the opposite side remain intact. Three months later he does the other side, if necessary.

Here is a fantastic case. The premaxilla had been excised at the time of closure of what was probably an incomplete bilateral cleft. Dautrey achieved advancement of the maxilla and opening of the cleft using his modification. When the patient was first seen at the age of 20, the mandibular arch was normal and the two remaining maxillary segments were in severe crossbite, with dental contact only at the right second molar. Cephalometrically the mandible was in relatively normal position, but its prognathism can be explained by the fact that, with a maxilla contracted in the vertical plane, the mandible had to go beyond the normal closing angle before making contact with the lonely molar, reminiscent of the pseudoprognathism of the edentulous elderly.

Dautrey moved the mandible back within striking distance by sagittal split with intermaxillary fixation. Then with extraction of a first molar, keeping the second molar and the maxillary arch on the other side as stable fixation points, he freed one two-tooth segment and rotated it into relation with the mandible. The movement was lateral and posterior and put the teeth into a usable maxillary arch. Fixation was achieved by a rigid arch bar from the shifted segment to the stable segment of the opposite side. In the second stage, the opposite maxillary segment was
shifted and fixed in similar fashion. The final result shows the patient without any soft tissue surgery but with a fixed anterior bridge in place.
FORWARD MOVEMENT OF THE MIDDLE THIRD OF THE FACE BY LE FORT III OSTEOTOMY

Gillies was the first to accomplish this maneuver, having become interested during the wars in maxillary refracture. As we wrote in 1952, and published in 1957:

A plethora of these upper jaw fractures since 1916 enables our War Office report to state categorically in 1939: "Malunion has occurred, interfering with mastication and/or appearance. Treatment—an attempt should be made to obtain union in a more favourable position by osteotomy.

An important case for Gillies was Airman Forbes, who crashed coming in from an operational flight, crushing his face against the dashboard with a type of Le Fort III fracture, plus splitting the hard palate and sustaining a symphysis fracture of the mandible. Immediate disimpaction and fixation resulted in a remarkable recovery which was exciting to Gillies.

LATE OSTEOTOMY

Another historic case concerned a Hurricane pilot who crashed, suffering severe fractures of the face with everything below the eyebrows pushed back. His spinal injury caused facial correction to be postponed one year. Then in 1941, with neurosurgeon Cone, Gillies made chisel cuts through nasal arch to floor of orbit—out to fronto-nasal synchondrosis—over to zygomatic arch—down spheno-maxillary suture (with osteotome)—lever behind last molar—entire maxilla rocked free. Forward retention maintained by 1-lb. weight and pulley attached to maxillary splint. . . . After a bone graft was implanted in the floor of the right orbit, the diplopia was reduced.

FIRST OSTEOTOMY IN CONGENITAL CASE

In 1949 Sir Harold Gillies performed the first osteotomy of the facial bones along the lines of a Le Fort III fracture to advance the mid-face in a nurse with Crouzon’s disease.
There was considerable postoperative loss of the maxillary advancement gained surgically in this case. In 1954, with Norman Rowe, Gillies acknowledged that bone grafts in the osteotomized spaces were necessary to maintain the advanced position of the maxilla.

Although Gillies was first with a Le Fort III, Paul Tessier of Paris has developed principles which now allow movement of any part of the upper half of the facial skeleton into any position.

Reed Dingman of the University of Michigan stated in 1977:

In the past, we have done mandibular setbacks when we should have been doing maxillary osteotomies with advancement.

He forwarded this interesting case of a 16-year-old boy who had his cleft lip closed at 1 week and his palate at 1 year in Detroit. He noted:

The nose had a large dorsal hump with a bulbous drooping tip and flattening on the side of the cleft. The upper lip was short and tight transversely with notching at the site of the lip repair. The middle one-third of the face was underdeveloped and recessed. There was relative mandibular prognathism and Class III malocclusion. The palate was very short but moved very well. The teeth were in fairly good condition and speech was satisfactory.
After consultation with orthodontist Ponitz,

On July 9, 1969, the patient had a tracheostomy followed by a Le Fort III-type maxillary osteotomy with mid-face advancement and bone grafts from the right iliac crest [Tessier]. Intermaxillary fixation was maintained by means of Erich appliances and rubber bands. Five days later a Georgiade halo appliance was added to apply forward traction on the maxilla. The patient was discharged on the 8th postoperative day.

After 4½ weeks, the halo apparatus was removed as well as the rubber bands. One week later the arch bars were removed. His occlusion was satisfactory. However, the patient's speech showed a great deal more nasality than before his operation. This was thought to be due to advancement of the palate leaving a larger velopharyngeal gap. Therefore, the patient had a superiorly-based pharyngeal flap and palatoplasty performed on November 18, 1969. Following this, his speech was again excellent.

In 1970 the patient had an Abbe flap and submucous resection for a deviated septal cartilage and later a corrective rhinoplasty.

Wolfe suggests that in a case such as this, without exorbitism, it may be preferable to use a Le Fort II osteotomy, since a Le Fort III can result in enophthalmos.

In the Le Fort III osteotomy, Wolfe noted:

There are enough points of osteosynthesis that the maxilla is often so stable in its new position that IMF is not necessary. This has been done in two patients now with no appreciable relapse over a 2 year period, and Tessier has had a similar experience.

The major monobloc shift of a Le Fort III corrects many problems simultaneously—retromaxillism, exorbitism, nasopharyngeal atresia, with often a dramatic improvement in facial appearance.
As taught by Obwegeser, it is important to keep the pterygoid plate intact to serve as a buttress against which a bone graft block can act to hold the advanced mid-face in the forward position. Here is a case by S. A. Wolfe in which a Le Fort III osteotomy had the advantage of a bone graft block placed exactly the same as in a Le Fort I. The tomograms show the bone graft in the space between the pterygoid plate and the maxillary tuberosity.

**SEPARATE FORWARD MOVEMENT OF THE MIDDLE THIRD OF THE FACE BY COMBINED LE FORT I AND LE FORT III OSTEOTOMIES**

When there is a disparity in the retroposition of the upper half and the lower half of the middle third of the face, each half poses a separate problem. Primarily, the upper half has an aesthetic deficiency with pseudoexorbitism, while the lower has functional impairment of occlusal imbalance. This calls for Le Fort I and III osteotomies simultaneously. The gaps are filled with bone, and fixation is maintained with intermaxillary wiring plus interskeletal suspensions.

Here is a dish-face deformity in a bilateral cleft case corrected by Obwegeser by advancement of the middle third of the face in two layers after Le Fort III and Le Fort I osteotomies, anterior
positioning of the premaxilla with bone grafting and closure of remaining fistulae and elongation of the columella and complete rhinoplasty. Cephalometric x-ray films show patient before and after surgery, but before dental prosthodontic work.

Professor Hugo Obwegeser is constantly involved in clinical teaching. In 1971 in *Cleft Lip and Palate* he set as the goal in hard tissue surgery of the maxilla in postoperative cleft lip and palate cases the old Gillies edict: *Replace into normal position what is normal and retain it there.* He noted that adhering to this principle required the following:

1. Correct the axes of inclination of the teeth with the alveolar process; create a normal arch, which may be done by surgery or by orthodontic treatment or by both methods.
2. Reposition the alveolar process so that its axis is properly aligned with the base of the jaw.
3. Establish acceptable intermaxillary and occlusal relationship; the new position should, of course, harmonize with the other parts of the facial skeleton.

4. Some cases require additional facial contour alterations. The main procedures are: onlays, recontouring a bone that is too prominent, or using a dental prosthesis.

Obwegeser's aids to preoperative planning are:

1. Photographs (front and profile views of the face and intraoral views—occlusal, palatal, and any special views needed).
2. Extraoral radiographs (cephalograms, standard views, orthopantomograms, and tomograms).
3. Intraoral radiographs (periapical and occlusal).
4. Dental examination: carious lesions, vitality, and periodontal tissues.
5. Study casts: one stone set to record the preoperative occlusion and the jaw relationship; two plaster of paris sets to be used for model operations.
6. Observe the functional movement of the mandible and the motility of the muscles of the facial expression; check the trigeminal nerve.
7. Record the patient's speech.
8. Evaluate the patient's total health.
9. Secure any additional indicated consultation of other specialists: e.g., speech therapist, orthodontist, prosthodontist, otolaryngologist, etc.

MALPOSED TEETH

In the presence of a good jaw and an acceptable alveolar relationship, malposed teeth can be corrected with orthodontia. Orthodontic treatment should be limited to aligning the axis of the teeth with the axis of the alveolar process. Creating an overjet by orthodontia results in little improvement in the patient's outward appearance—the teeth and/or alveolar process inclining too far anteriorly while jeopardizing periodontal tissues—and renders subsequent surgical correction of the profile more difficult.

SOPHISTICATED SEGMENTAL PROCEDURES

Corticotomy

It often takes a long time to move adult malposed teeth by conventional orthodontic methods alone. Corticotomy combines
surgical and orthodontic treatment and, by decreasing bony resistance, shortens the time factor. In 1958 Heinrich Köle of Graz described this technique. A gingival margin incision allows reflection of the mucoperiosteum in the selected area. A thin bur is used to make vertical cuts through the cortical plate of the alveolar bone on the buccal or palatal side, depending on which direction the surgeon desires to move the teeth. The vertical cuts are placed on both sides of each tooth selected for movement and extended to a level just above the apices of the teeth. The mucoperiosteum is replaced, sutured and allowed to heal about 10 days before orthodontic movement is begun.

Unilateral rotation of small alveolar segment
A common deformity in clefts of the alveolus and hard palate is the upward and inward displacement of the alveolar process and its teeth on the cleft side. As noted by Gillies and Millard in 1957 in The Principles and Art of Plastic Surgery, this segment has to be tilted downward and rotated laterally. As pointed out by Norman Rowe in 1954, the axis for both movements is an imaginary line extended through the maxillary tuberosity. In Obwegeser’s diagrams for Cleft Lip and Palate, the broken line marks the mucoperiosteal incision and the bone cut by bur as a horizontal osteotomy from the pterygomaxillary fissure anteriorly to the pyriform aperture at the level of the infraorbital foramen (A).

An osteotomy is also done on the lateral wall of the nose just below the level of the inferior concha. Bony connections, between the halves of the hard palate and mucosa of the nasal floor, are cut with a small osteotome. A heavy elevator is used to pry the segment into the desired position. This rotation creates two
fractures: The posterior wall of the sinus will fracture, and the pterygomaxillary fissure will greenstick fracture (B). The mobile fragment should be held in corrected position for six weeks by a preoperatively applied splint fixed to the other side of the upper arch. The upper arch and palate is shown before operation by Obwegeser (C). The upper arch and palate is seen after lateral rotation of a small segment and closure of reopened cleft using a vestibular flap as oral layer in the anterior palatal area and after definite bridgework constructed by patient's dentist (D).

Obwegeser noted:

The goal of all these procedures—the osteotomy, the repositioning of the displaced alveolar segment, cleft closure with bone grafting, and postoperative orthodontic treatment—is to create normal occlusion, and to create more favorable conditions for the construction of a denture or a fixed bridge. All of these, of course, improve the appearance of the face.

**Rotation of bilateral alveolar segments**

The management of a bilateral case is similar to that of a unilateral case. Both sides are rotated simultaneously with greenstick fractures in the tuberosity areas. In addition to intermaxillary fixation, interskeletal suspension, usually by circumzygomatic suspension wires, is required. If the premaxilla needs repositioning, this is done later with bone grafting, at the same time that the cleft is closed.

**Unilateral complete clefts**

The smaller segment is moved as already described. The incision for the larger segment is carried across the midline and extended into the cleft. The mucoperiosteum is reflected, the nasal spine removed and the vomer separated from the palate. The bone cutting and repositioning are similar to those on the other side. As soon as the fragments are mobile, the smaller segment is positioned laterally first. If the mucosa of the vomer prevents lateral rotation of the large segment, it is incised at its junction at the floor of the nose under direct vision. Fixation and intermaxillary immobilization are essential.

**Reducing broad maxillary arch**

As noted by Hugo Obwegeser, an orthodontically overcorrected
maxillary arch may be too broad, with the teeth flared. Also, in cases of retromaxillism, surgical bilateral rotation of the alveolar segments without forward repositioning may produce an arch that is too broad. To compress such an arch, tissues must be removed from the cleft area of the hard palate and the alveolar process. With limited reflection of palatal mucoperiosteum, the planned amount of bone and soft tissues along the margins of the palatal cleft is removed. The broken lines mark the bone cuts, which are carried out as in the outward rotation technique. The arrows indicate the direction the palatal segments are moved in order to compress the arch.

**Osteotomy for tilting premaxilla**

When the premaxilla is tilted palatally but lateral occlusion is satisfactory, the base of the premaxilla is fractured. Obwegeser varies the incision. With an open cleft, the bone cut is made through the cleft; with a closed cleft, it is made on the palatal side. After the soft tissues have healed, the orthodontic tilting is quite quick and easy with the soft tissues stretching. He noted:

If the teeth are to be used as bridge abutments, the premaxilla should have bony union with the lateral segments. . . . Therefore, it is usually wise to do both the osteotomy for the tilting and the bone implantation all in one stage.

**Severe maxillary deformities in bilateral clefts**

Obwegeser admitted that he, as well as Barsky, Kahn and Simon (1964) and Pfeifer (1966), followed this sequence in a three-stage procedure: (1) retropositioning the lateral alveolar segments, (2) closing the reopened cleft and (3) carrying out the premaxillary osteotomy, repositioning and secondary osteoplasty. He hailed Perko's 1964 plan for premaxillary osteotomy and cleft closure with simultaneous bone grafting in one operation as the second stage, after repositioning of the lateral alveolar segments. His series of diagrams demonstrates this two-stage design.
He presented an impressive case in *Cleft Lip and Palate* treated in this manner.

*Various movements of the anterior segment of the maxilla*

As noted by H. Obwegeser of Zurich:

Whether an anterior segment of the maxilla is to be moved forward or backward, the principles of planning and of operative techniques are similar. Also, the methods of bracing or stabilizing it are the same. One very seldom sees a true maxillary protrusion in patients with clefts. In such patients the planning and the principles for the correction of maxillary protrusion are
similar to the techniques used with noncleft patients. Since the reopened cleft provides better access to the operative site, it is simpler.

**Backward segmental movement**

In 1935 Wassmund of Berlin developed a technique of segmental ostectomy to correct open bite by retrusion of the maxillary median fragment, thus causing a deep bite.

Here is a case of premaxillary protrusion, or "proalveolie." The patient had had the upper first bicuspids extracted, and even after years of orthodontic treatment she still had a premaxillary segment that was 8 mm. too far anteriorly and 6 mm. too far inferiorly.

Wolfe described his one-stage surgery:

First, extraction of the remaining upper bicuspids. A transverse incision 1½ cm. in length made across the area of the nasal spine. Subperiosteal dissection carried up from the dental extraction sites across the premaxillary alveolar bone to the nasal spine incision bilaterally, enough to allow a small retractor to reflect the mucoperiosteum enough to permit the vertical osteotomy to be done with a small burr. The vertical osteotomies were carried up from the dental extraction sites, and the required 8 mm. of bone removed without damaging adjacent teeth. Transverse osteotomies were made just above the level of the pyriform aperture, but the nasal spine was left attached to the septum, which was then sectioned. A curved osteotome could then be introduced through the space beneath the nasal spine, and the palatal bone sectioned from above, with a finger held against the palate from below to be sure that the palatal mucoperiosteum was not damaged. The premaxillary segment was then free, and remaining segments of bone of
palate and alveolus could be removed under direct vision. The segment was moved into its predetermined position and was fixed to a prefabricated acrylic splint which was solidly attached to the stable posterior maxillary segments. Intermaxillary fixation was not required. A sliding genioplasty was performed at the same time.

Comment: This procedure preserves almost all of the mucoperiosteum on both sides, palatal and labial, of the premaxillary segment, and is thus much safer than the original Wassmund-Wunderer method.

In 1959 Köle of Graz described the posterior and vertical repositioning, avoiding deep bite by splints. The maxillary median fragment was elevated; thus normal occlusion was obtained posteriorly. Elastics were later replaced by intermaxillary wires.
In 1964, in *Reconstructive Plastic Surgery*, John M. Converse, with Sidney L. Horowitz and Donald Wood-Smith of New York, described a simple surgical advancement of the anterior portion of the maxilla by bilateral extraction of premolar teeth with the line of osteotomy extending through the site of extraction to the pyriform aperture and a further osteotomy of the vomerine attachment to the floor of the nose. . . . Advancement of the anterior maxilla and maintenance of advancement by orthodontic fixation appliances and interposition of split rib bone grafts.

In 1971, in *Cleft Lip and Palate*, Obwegeser presented his technique for forward retropositioning of the anterior part of a large alveolar segment in a case of unilateral cleft. As noted, this approach was much like that of Wassmund (1935) and Wunderer (1962). The moving maxillary segment received its blood supply through the narrow pedicle of vestibular mucoperiosteum. The defects were filled with bone, and the gingiva was moved to cover portions of the bone graft, as the arrow indicates.

*Moving posterior segment of maxilla*

In 1959 Schuchardt of Hamburg described a posterior maxillary osteotomy in which the posterior maxillary alveolar segment was freed and impacted into the maxillary sinus. This is a useful procedure in cases of anterior open bite in which the vertical facial height deserves reduction that can be achieved in one stage through a short buccal incision. The medial osteotomy must be done with accuracy, since the distance between the tooth root and the nasal cavity is only about 3 mm.
When there is a marked flatness of the middle third of the face, giving a "dish-face" effect, but dental occlusion is satisfactory, the preferred methods of correction are:

1. Mobilization and forward motion of the upper half of the middle third of the face, according to the method of Tessier.
2. Use of onlays of bone or cartilage inserted through an intraoral approach to the canine fossa and the paranasal areas. Even if surgical repositioning of the maxilla or mandible, or both, has achieved satisfactory occlusion, there may be residual flatness of the profile. Here onlays can be of great value.

If enough teeth remain, a special cover denture can give support to the lip. Often this will require buccal inlay procedures to facilitate application of the denture with especially overbuilt flanges to alter the profile in specific areas.

Of course, all the methods described for moving the maxilla and the mandible can be used in simultaneous combinations in an
But it is not easy to decide where the bloc should be positioned in relation to the remainder of the facial skeleton. This is especially difficult because one can move this bloc in all directions.

Obwegeser's upper and lower jaw juggling mastery is superbly demonstrated in four of his cases.
The first reveals retromaxillism and severe ectropion of the lower lip, corrected by advancement of the maxilla and retropositioning of the anterior mandibular alveolar segment (A, B). Models show preoperative occlusal situation and details of planning. (C) shows preoperative circular non-oclusion, (D) occlusion after surgery, and (E) final occlusion with replacement of missing second upper right incisor. (F) shows collapsed maxillary dental arch before surgery, (G) upper dental arch after advancement of maxilla in 2 sections with reopening of palate cleft, and (H) upper dental arch after orthodontic treatment by P. Stöckli, University Dental School, Zürich. Cephalometric X-rays show before and after bone surgery using homologous deep frozen bank bone. Profiles present before bone surgery, after bone surgery, and after columella elongation using Millard's forked flap.

This unilateral cleft case with retromaxillism and mandibular prognathism was corrected by Obwegeser and partially published in *Deutsche Zahnärztliche Zeitschrift*, 1973. Surgery involved:
(1) Advancement of maxilla in 2 sections and simultaneous retropositioning of the whole mandible using sagittal splitting procedure. (2) Re-operation of palate with bone grafting for closure of remaining cleft fistula. (3) Rhinoplasty for correction of nasal deformity and revision of lip. Models show plan of osteotomies and cephalometric X-rays show progress of surgery.
This bilateral cleft case with mandibular prognathism and collapsed maxilla with severe nasal deformity was corrected by Obwegeser and presented in the Transactions of the Fourth International Congress of Plastic and Reconstructive Surgery, Rome, 1967. The following procedures were used:

1. Lateral rotation of lateral maxillary segments with reopening of cleft according to Gillies.
2. Closure of reopened cleft with simultaneous bone grafting.
3. Repositioning of premaxilla.
4. Retropositioning of whole mandible using Obwegeser's sagittal splitting procedure.
5. Elongation of columella by Millard's forked flap and simultaneous reoperation of bilateral cleft lip correcting whistle defect without an Abbe flap.

Models (A) show preoperative occlusion and plan of corrective surgery. Also shown are the preoperative circular non-occlusal view (B), the perfect occlusion after repositioning of maxillary
segments and mandible (C), the occlusal view after final prosthodontic reconstruction by J. Wirz, University of Zürich (D), and the palate view (E).

This bilateral cleft case with mandibular prognathism, anterior open bite and retrusion of the premaxilla was treated by M. Perko and E. Steinhauser according to planning by Obwegeser.

(1) Mandibular ostectomy through oral route by Obwegeser method.
(2) Repositioning the premaxilla, closure of remaining palatal fistulae with simultaneous bone grafting and retropositioning of anterior mandibular alveolar segment and (3) revision of bilateral lip scars. (4) Elongation of columella.

(A) Models show preoperative condition and model-operation for osteotomies presents plan.
(B) preoperative occlusion.
(C) postoperative occlusion.
(D) occlusal view after prosthodontic work by J. Wirz, University of Zürich.
(E) palate view.
Preoperative and postoperative cephalometric views and patient's profiles show the result.

Converse's case of mandibular prognathism combined with maxillary retrusion is a 33-year-old female who had a cleft lip closed at birth and cleft palate closed at 18 months. This was his summary:

At 32 years of age, she underwent a Le Fort 1½ maxillary advancement of 10 mm. and six months subsequent to this, the correction of malocclusion was finalized by a vertical osteotomy, with an 8 mm. set-back. The combination of these two procedures was necessary in this patient because of the wide occlusal disparity. Included with the photographs are the cephalogram tracings.
Occasionally patients with cleft palate who have had surgical correction of dysgnathia—maxillary and mandibular abnormalities—suffer partial relapse. If the cause of the dysgnathia deformity is still present at the time of the surgery, partial relapse is a possibility. Other factors include the higher tendency for relapse in the growing patient, insufficient bony union and failure to obtain complete mobility of the fragments at the time of repositioning. Obwegeser warned:

Palatally malposed lateral maxillary segments that had been treated by the combined surgical and orthodontic (expansion plate) method [W. Widmaier, 1960] showed a very pronounced tendency to relapse if, at surgery,
the segments had not been made completely mobile. In these cases only a tilting, not a true lateral movement, had been achieved. This is similar to the procedure of the forced expansion without osteotomy [H. Derichsweiler, 1955; E. Nordin and B. Johanson, 1955]. This non-surgical forced expansion affects the base of the maxilla very little [L. Rinderer, 1965]... The tendency for relapse is much less if the surgeon places bone along the path of the bone cut. This precaution seems to ensure a better bony union... Defects between the margins of a repositioned segment and its host site do not always become filled by bone automatically; soft tissues may fill in, and these contract, which may result in a dislocation. To obviate this the defects are closed with a bone transplant, which is pressed snugly into the defect. The iliac bone is my choice of donor sites for the bone grafts and the medullary paste. In some cases, however, rib grafts or bone from the chin prominence are used. Occasionally we have also used autologous or homologous frozen bone with good results.

Additionally, after the fixation is removed, a retention denture is inserted. This counteracts the scar contraction in the cleft area. Also, after a secondary osteoplasty for stabilization of the segments, a temporary denture should be provided until the definitive denture or bridge is inserted.

In some cases my co-workers and I have performed the procedures described above in patients aged 10 years and older. We have the impression that there is a higher tendency for relapse in the younger patients' cases than in those patients operated on after the age of 17 years. This seems attributable, in part, to scar formation in the soft tissues; the scar dislocates the segment and interferes with further growth. It seems that even the surgical intervention itself adversely affects growth. However, the number of cases operated upon in youth is too small, and we cannot yet judge definitely whether these operations can be done during the growing period with the same final results as when they are performed when growth is terminated.

In 1977 Hans P. M. Freihofer, Jr., summarized the experience of 100 cases in relation to timing osteotomies of the facial skeleton in adolescence.

1. Generally speaking, osteotomies in adolescence have to be refused before growth has ceased. Exceptions to this rule are very marked functional and psychological indications. In these special cases, however, the patient and his parents have to be told of the likelihood of changes in the postoperative result due to further growth. The necessity of a second later operation cannot be excluded.

2. It is difficult to give a precise age limit for operations because of the variation in time to growth completion. The cases presented, however, show that the 17th year of age is frequently too early. Boys are more at risk in this...
respect than girls and cleft patients more than non-cleft patients. We would suggest a rule of thumb, namely, that girls should have reached the age of seventeen and boys the age of 18 at least before osteotomies are performed. As an exception again, we would like to cite those cases for which a series of cephalometric X-rays can be presented proving earlier termination of growth, with a very high degree of probability with respect to accuracy.

3. The main reason for clinically unacceptable results is further forward growth of the mandible. The combination of partial true relapse and further forward growth of the mandible influences the results disastrously. True relapse of the operation alone seems to play a secondary role.

4. The osteotomies have no influence on the growth of the mandible.

5. A negative influence of osteotomies on growth of the maxilla could not be proved. However, several indications are given that it does in fact exist.

6. Comparison with data in the literature proves that particularly in the treatment of Angle class III cases more unfavourable results are obtained in adolescents than in adults. There is thus a danger of true relapse and pseudo-relapse following a retropositioning of the mandible, backward displacement of the lower anterior segment, advancement of the whole midface and advancement of the maxilla.

7. Retropositioning of the maxillary anterior segment and advancement of the mandible as a whole are the only operations which can be performed without risk before growth is completed. In these groups, results are comparable to those obtained in adults.

8. The treatment of open bite is accompanied by special problems. Residual growth plays a part, but results are also unsatisfactory in adults if certain surgical techniques are applied.

Osteotomy of the premaxilla and its stabilization, on the one hand has to be seen in the context of the complete treatment plan of a cleft patient, and on the other hand has to be considered in the light of the experiences gained in the advancement of the maxilla. To achieve good results in the rotation of the small maxillary segment in cleft patients, operative technique and post-operative treatment have to occur under optimal conditions.

9. Most questions which had to be left totally or partially open, can be answered by specific studies. The most important and difficult problem to be solved is the question of negative influence of osteotomies on maxillary growth.

10. It is to be hoped that the number of osteotomies performed during adolescence will decrease markedly as a consequence of the results presented. Patient and surgeon would therefore be spared the disappointment of failure and further strain of reoperation. However, exceptional cases will always be found in which a special indication is present for surgery during growth. Surgeon and patient must then be aware of the problems involved.
TEETH VITALITY AFTER SURGERY

In reconstructive dentistry, the vitality of the teeth is an important aspect. Obwegeser's experience is encouraging:

Pulpal injury is rare, even in cases in which the segment has been moved as much as 20 mm. Though the immediate postoperative vitality test is negative, after a time the response becomes positive. This means that within 6 to 9 months, the teeth in a repositioned segment will usually respond positively to the vitality test. The positive response appears earlier in maxillary teeth than in teeth in a mandibular segment.

EFFECT OF MAXILLARY ADVANCEMENT ON SPEECH

One of the possible side-effects of forward advancement of the maxilla after osteotomy is velopharyngeal incompetence. Pulling the soft palate forward to its attachment to the hard palate may render the velum unable to participate with the pharyngeal wall in the sphincteric action during phonation. If there was minimal contact prior to osteotomy, the effect could be devastating to speech. The risk, however, does not seem to be large, as noted by those who are following maxillary surgery in cleft palate patients.

In 1977 Ralph Bralley and Z. G. Schoeny of the University of Virginia reported a 19-year-old patient with a surgically closed submucosal cleft palate who was evaluated following a Le Fort I osteotomy, to determine the effects of the surgery on his speech. Preoperative and postoperative tape recordings during administration of an articulation test, casual conversation and repetition of standard sentences, along with preoperative and postoperative spectrographic analysis of standard sentences, revealed that maxillary advancement had no adverse effect on articulation ability or voice in this case. The authors stated:

However, an unexpected and substantial reduction in the magnitude of the third formant in the postoperative recording was noted. The existence of hypernasality in speech has been shown to be associated with increased magnitude of the third formant (Hattori, Yamoto, and Fujimura, 1958). The observed reduction in magnitude of the third formant may have resulted from an increase in the oral cavity size giving added resonance to lower frequencies. The increase of resonance in the lower frequencies may exert a second-
ary benefit to speech and, therefore, deserves consideration in the evaluation of the patient who is being considered for maxillary advancement.

Mutaz B. Habal of the University of South Florida, Tampa, trained by J. Murray in Boston, reported at the Florida Cleft Palate Association meeting in Miami, 1978, that Le Fort I osteotomies had been carried out on a series of 25 secondary cleft palate cases. He noted that all had normal speech preoperatively and none developed velopharyngeal incompetence after maxillary advancement.

In 1979 Joseph G. McCarthy, P. Coccaro, M. Schwartz, D. Wood-Smith and J. Converse noted in reference to velopharyngeal function following maxillary advancement:

A prospective study of 40 patients, who underwent maxillary advancement, included preoperative and serial postoperative cephalometric analysis, aerodynamic evaluation of velopharyngeal orifice area and Templin-Darley articulation testing. The group was subdivided into those with (11) and those without (29) a cleft palate. Distinct anatomical differences in the velopharyngeal area between the cleft palate and craniofacial dysostosis group was detected. Consequently the cleft palate group is more at risk for the development of postoperative velopharyngeal incompetence. No patient developed hypernasality after maxillary advancement. On cephalometric analysis there was a definite postoperative change in the posture and position of the velum; nasopharyngeal volume was also increased. Hyponasality was eliminated in 4 patients with Crouzon’s disorders.

Industrious Kenneth E. Salyer of the University of Texas Southwestern Medical School, Dallas, extensively involved in craniofacial surgery, expressed some thoughts in 1978 on maxillary advancement and velopharyngeal competence:

The Le Fort II maxillary advancement is an excellent procedure in cleft patients as it allows the advancement of the nasal spine and nose as well as augmentation of the hypoplastic maxilla and correction of the occlusal problems to be accomplished in one procedure. In both cleft and non-cleft
patients, it is important to assess the velopharyngeal mechanism as incompetence may result following facial advancement. Contrary to some of the literature on this subject, we have found that patients with adequate touch closure prior to surgery on occasion develop velopharyngeal insufficiency after facial advancement. Correction of this condition with a pharyngeal flap should be postponed until one year following advancement as the pull of the flap can contribute to relapse of the maxillary advancement if performed earlier after facial advancement.

To overcome or circumvent this possible untoward result, we have found it advantageous to utilize a one centimeter osteotomy across the palate just anterior to the edge of the bony palate, leaving the horizontal palatal bones intact in patients where we do not want to alter the existing velopharyngeal anatomy. In Le Fort II advancement, exposure is provided by a mucoperiosteal bilateral palatine flap. This type of surgical approach offers maintenance of the position of the hard palate. Another advantage lies in the facilitation of advancing the maxilla, particularly in the cleft patient where palatal scarring hinders and makes it difficult to maintain the advanced position of the maxilla. Elimination of tethering of the maxilla is but another advantage to this type of surgical procedure. Due to possible interference with the blood supply of the maxilla, it is not possible to use this approach in a Le Fort I advancement in the cleft patient.

In patients undergoing maxillary advancement subsequent to the insertion of a pharyngeal flap, it is important to advance the pharyngeal flap for length as advocated and performed by Tessier and reported by Whitaker. This subject is treated in more detail in Chapter 42.
VIII. Evaluation and Habilitation
A comment by Kilner on his approach toward judging palate speech results is interesting:

In the past, surgeons were satisfied if they could exhibit completely closed palate defects and much ingenuity has been shown in developing ways and means of obtaining such results. Today the tongue depressor and torch should play no primary part in the examination of repaired palates. If the patient can speak clearly and naturally, if he can snort (Wardill) and if he can blow up a balloon or extend a “carnival blower,” it is obvious that he possesses efficient naso-pharyngeal sphincteric control and no visual examination is needed to indicate whether the repair operation has been successful.

**BZOCHE**

In 1977 Bzoch of the University of Florida wrote:

The evaluation of velopharyngeal adequacy or inadequacy following primary palatal surgery does not appear to be as complicated as many of our research colleagues in the field of speech pathology indicate. It can be undertaken between 12 and 18 months of age following primary closure as a routine. Palatal valving is adequate for speech when it can be demonstrated to support normal syllable speech production. Therefore, clinical tests focusing directly on speech behavior with observations of the frequency of normal or abnormal nasal emission occurrence while impounding the breath stream for simple speech utterances, such as the word *puppy* or *paper*, provide one important index of palatal adequacy and can be obtained even with very young children. The second important direct index is a count of nasal
resonance tone shift by the cul-de-sac resonance test, where the nares are
alternately pinched and left open during the utterance of simple words. The
shift in tone, if hypernasal resonance is present, can be picked up even in a
noisy chairside situation with a cooperative youngster.

MILLARD

Robert T. Millard, chief of speech and hearing at the Lancaster
Cleft Palate Clinic, in 1977 discussed the cleft palate problem
lucidly:

In a nutshell, the person with a cleft condition may have a problem of voice
quality and/or articulation. One must establish the adequacy of velopharyngeal
function. Inadequacy or incompetency of the velar mechanism
promotes hypernasality. For most patients, hypernasality can be effectively
reduced with surgery or a prosthesis—according to the dictates of the team.

Articulation disorders are subject to the age of the patient and to
violation of the rigidity of phonetic classification. Consonant sounds are
charted according to manner of production and placement of the articula-
tors. That’s it. A study of the patient’s errors according to placement or
manner of production determines the mode of therapy.

My credo is listen to speech, then look at the mechanism in action. The
patient does or does not have adequate velopharyngeal valving. The patient
does or does not have adequate placement for consonant sounds. The
patient’s manner of sound production (plosives, fricatives, etc.) is or is not
acceptable.

Design your therapy to meet the needs of your diagnosis with or without
the services of the plastic surgeon or prosthodontist. There is no special
“cook book” treatment—just common sense derived from experience of the
team.

BENSEN’S COOKBOOK

In 1977 in Plastic and Reconstructive Surgery Jack Bensen, speech
pathologist at the University of Miami, presented a fairly accurate
five-minute velopharyngeal competence testing checklist for the
plastic surgeon without a cleft palate clinic.

A CHECK LIST FOR EVALUATING SPEECH

1. Running conversation
   ______ Normal
   ______ Deviant from normal
2. Counting to 20

Voice quality
sounds normal

Voice quality
slightly nasal

Voice quality
very nasal

If normal, you can stop here

3. Production of /a/ “Ah”

Visual observation of palate

Good movement—closure

Moderate movement—appears short

Slight movement—appears short

No movement

Auditory impression

Sounds normal

Sounds nasal

4. Production of /pa/ “Pah”

Visual observation of palate

Maintains closure

Palate appears to drop when the /a/ “Ah” is produced

Auditory impression

Sounds normal

“Ah” sounds nasal

Nasal emission of air on /p/

5. Production of /ta/ “Tah,” repeated rapidly

Sounds normal

Slight nasal emission of air

Nasal snorts

6. Production of /f/, prolonged

Sounds normal

Slight nasal emission of air

Nasal snort

/fa/ “Fah,” repeated rapidly

Sounds normal

Slight nasal emission of air

Nasal snorts

7. Production of /s/, prolonged

Sounds normal

Slight nasal emission of air

Nasal snort

/fa/ “Sah,” repeated rapidly

Normal

Slight nasal emission of air

Nasal snorts

Bensen noted that if speech is normal during conversation there is no need for further testing. Observation of the velopharyngeal mechanism through the open mouth during ab will reveal palatal movement, and, during pah, if the palate rises and is making a downward excursion on the ab, the patient probably has the potential for closure. Further palate surgery is necessary if there is distinct sound of “cleft palateness” plus no observable movement. Speech therapy should produce near-normal speech when there is good observable movement of the palate, no nasal
emission on plosives, some nasal escape on the fricatives. Speech therapy may help, but additional surgery is probably necessary when there is nasal escape on fricatives and some plosives, with the palate appearing short and motion sluggish and nasal speech during conversation and counting.

HOOPES

Dedicated John E. Hoopes of Johns Hopkins Hospital, Baltimore, Maryland, at present divides his life between plastic surgery, training residents and occasionally escaping the former two by going sailing, "deriving an exquisite pleasure from celestial navigation." In 1977 Hoopes wrote:

My interest in cleft palate and resultant speech began in approximately 1964, and was stimulated by the plethora of non-information and personal opinion extant in the literature. It seemed clear that there existed no objective assessment of the results of palatal repair other than listener judgment and it seemed clear that listener judgment could not be compared between institutions; therefore, truly objective assessment of the results of palate repair was not available.

In 1968 in *Plastic and Reconstructive Surgery*, with Jacob Fabrikant, Hoopes noted that methods for objectively demonstrating velopharyngeal function had contributed valuable information, but all had been proved to have certain limitations. They discussed the various methods:

Direct Inspection

Direct observation of the soft palate, through a defect secondary to orbital exenteration, was first described by Wardill and Whillis (1935); similar observations were made by Calnan. . . . Although this information has been of value in speech research, there is minimal correlation between the appearance of the velopharyngeal structures and the speech which they are capable of producing.

Radiography. . . .

Cephalometry. . . . The limitations of the procedure are related to the single film, sagittal plane technique.

Tomography. Hage and Brauer utilized tomography to determine the length gained by palate pushback procedures. . . .
Cineradiography. Cineradiographic evaluation of velopharyngeal function offers the advantage of direct and measurable visualization of palatal excursion during speech. There exists strong positive correlation between measurements of velopharyngeal closure by the cineradiographic technique and speech ratings. The addition of synchronous sound recording by Bjork is a refinement contributing to the value of the procedure. The major limitation of the technique is that, at present, motion can be observed only in one plane.

Nasal Air Escape
Measurement of the quantity of air escaping through the velopharyngeal orifice during speech has played a significant role in the continuing search for a satisfactory method for evaluating speech objectively. Kymographic tracings of nasal air escape were reported by Biebendt in 1908. This area of investigation was pursued by Buncke and Chase. Sophistication of the technique by Warren has allowed the precise calculation of velopharyngeal orifice size. A number of objections have been raised regarding the value of the technique. Spriestersbach demonstrated radiographically that 38 of 47 patients used the tongue and palate, rather than the velopharyngeal sphincter, to valve for puffing. Calnan reported on a group of 225 patients, all of whom exhibited palato-pharyngeal incompetency during phonation, but 85 of whom achieved closure during blowing. McWilliams emphasized speech demands velopharyngeal behavior that is physiologically different from that required for blowing.

Acoustic Analysis
The technique of analyzing speech acoustically has been applied to cleft palate subjects only to a very limited degree. Bjork suggested that analysis of sound spectrograms, synchronized with cineradiographs, might form an important basis for assessing speech results postoperatively. Weatherley-White utilized a prototype instrument.

Electromyography
Electromyography still remains, at this time, a basic research tool without demonstrated clinical applicability.

The Bionic Palate
Through the work of Hoopes and Fabrikant and Yules, Northway and Chase, functional velopharyngeal relationships were being defined more precisely by means of cineradiography.
Meaningful interpretation of data within the total framework of the pertinent functional anatomical variables called for the construction of a functional mechanical model of a velopharynx. Lee Dellon, with the assistance of John Hoopes, at Johns Hopkins Hospital, constructed a palate analogue.

As noted by Dellon and Hoopes in the *British Journal of Plastic Surgery* in 1970:

The palate analogue gives dynamic representation only to the levator and tensor veli palatini muscles and the palatopharyngeus muscle. . . .

The hard palate is represented by a rigid plate which is variable in position with respect to the posterior pharyngeal wall. The soft palate is represented by a flexible elastic structure which is variable in length. The posterior pharyngeal wall is represented by a fixed rigid plate. Three muscles: (1) levator veli palatini, (2) tensor veli palatini, and (3) palatopharyngeus are represented bilaterally by silk ligatures which are variable in length, i.e., can be "contracted". The levator insertion is variable in position throughout the length of the soft palate.

The palate analogue is claimed basically to be

a manual analogue computer which is "programmed" to "read out" visually in terms of velopharyngeal incompetence and type of closure after being "fed" such data as levator insertion, depth of nasopharynx, and soft palate length.

Dellon and Hoopes stated:

At the anatomical level, the palate analogue provides a dynamic view of the relationships between structure and function. At the speech pathology level, the palate analogue provides a powerful instructional tool capable of
visually demonstrating the aetiology of hypernasality and nasal emission on the basis of anatomical variables. At the surgical level, the palate analogue provides an objective rationale for the selection of specific surgical techniques best suited to the individual case. With regard to this latter explanation, a patient's cineradiographic data can be converted to palate analogue scale and plotted ... to illustrate graphically which of the anatomical variables are abnormal and to what degree surgical correction is required. Decisions regarding palate lengthening procedures and/or surgical augmentation of the posterior pharyngeal wall can be entered into with precision.

Anterior levator insertion—compensated closure vs. adenoids

Anterior levator insertion—compensated closure after posterior pharyngeal implant or pharyngoplasty

**AERODYNAMICS OF THE VELOPHARYNGEAL ORIFICE**

*Spriestersbach*

Duane C. Spriestersbach, dean of the graduate school at the University of Iowa, has had his pioneering work in cleft palate speech pathology facilitated by a remarkable ability to work with, but without threatening, other specialists of his team. In 1977 he recalled the beginning:

While a young, new assistant professor in speech pathology in a department with a long-standing research tradition, the senior member of the faculty responsible for cleft palate resigned, and suddenly I had a great deal of learning to do. My mentor, Wendell Johnson, advised me to concentrate in depth on some aspect of speech production and soon I would identify more questions than I could ever answer. I tried to follow his suggestion and have never run out of questions. Dean Lierle, the head of the Department of Otolaryngology, gave me an appointment in his unit and started me on my way working in interdisciplinary environments.
A colleague in our department had developed a detailed, systematic interview technique for studying the families of children who stuttered. This was adapted to the study of families of children with clefts, and on the third try, N.I.H. agreed to support an extensive study of the psychosocial aspects of the “cleft palate problem,” which included medical, dental, speech, audiometric, radiographic and psychological examinations. Previous speculation about effects of poor physical development of the child with a cleft questioned respiratory supply and control. A wet spirometer gathering dust in the laboratory was mobilized for measurements and the patients, of course, had to hold their noses. We took measurements both with the nostrils closed and open and later began to see a relationship between the ratio of closed and open measures and the adequacy of speech articulation. Out of this effort, not unlike the fortuitous roasting in Lamb’s Dissertation on Roast Pig, grew the development of the oral manometer with a “bleed” that provides a clinical measure of the efficiency of the velopharyngeal valve used today.

Since our psychosocial study was long-range, we found ourselves dealing with peripheral data and were embarrassed for ourselves and others for the unwarranted assumptions about the homogeneity of cleft populations in previous research. Our growing insight about this reality caused us to look for better specifications of the physiological requisites for adequate speech, appreciating the variances that could exist within the functions of the several structures responsible for the total speech mechanism.

Frequently, when one asks a surgeon (or dentist or speech pathologist) how he or she accounted for a particular superior result, the answer is, “Well, in my hands. . . .” This is not where the communication should end. Clinical research is difficult but no less inherently scientific than basic research; every clinician is a researcher who should communicate, test and validate. The consequences of such an approach improve our chances for expanding the body of knowledge on which the quality of our lives, and perhaps our survival, depends.

Warren

Donald W. Warren, chairman of the Dental Oncology Department, University of North Carolina School of Dentistry, was brought up in the Flatbush section of Brooklyn and went south to the University of North Carolina at age 17 with his belongings packed in a laundry bag. During his dental school days, he married a young lady with a love of horses. After he learned to ride, he became interested in fox hunting and ended up president of the Red Mountain Foxhounds out of Rougemont, North Carolina. As he says:
After a hard day at the orifice (velopharyngeal, that is), I usually take off on my horse for a few hours of unwinding. Erle Peacock told me it was an adolescent trait that would not last. However, the last time I saw Erle, he mentioned that he bought a horse and now rides off into the sunset around the mountains of Tucson.

While studying at the Lancaster Cleft Palate Clinic, Warren became interested in palate studies. Using measurements of airflow through the nose and air pressure in the mouth in a ratio, he developed a formula that can predict the size of the velopharyngeal port. In 1977 he wrote his thoughts on this in cleft palate:

The effect of cleft palate on the respiratory components of speech was recognized long ago and a number of crude devices have been developed to provide a gross assessment of palatal function. These devices include, among others, U-tube manometers, mirrors which record nasal fogging, and various blowing devices which, at best, provide a gross indication of nasal escape.

The use or abuse of assessment tools depends to an extent on the clinician's understanding of the effects of palatal incompetency on speech performance. Complete separation of the nasal and oral chambers should occur for all consonants except m, n, and ng. However, normal voice quality and intelligibility can still be achieved in the presence of very, very small openings. Studies indicate that some normal speakers may have palatal openings of 1-3 mm² for non-nasal consonants during speech. Usually, however, the sphincter is tightly closed.

In cleft palate individuals, the upper limit of velopharyngeal adequacy is approximately 20 mm², although in most instances it is as small as 10 mm². The reason for this variation is that many other factors affect speech performance besides palatal closure. For example, in the range of 10 to 20 mm², the position of the tongue and mandible during phonation influences the amount of air which leaks into the nose. High tongue position impedes airflow through the nose and mouth and since air will flow through the region of least resistance, this results in greater nasal emission through the palatopharyngeal opening. Similarly, greater effort during speech also increases nasal emission of air, regardless of the size of the palatal opening. While the range of adequacy varies up to 20 mm², greater than 20 mm² is always inadequate for normal speech.

The effects of tongue placement and other compensatory phenomena associated with clefting are emphasized because in most instances, the measurements obtained by simple manometric tools such as U-tube manometers and blowing devices are influenced more by these activities than the degree of incompetency present. Thus, an instrument which measures
nasal emission of air alone may reflect effort more than palatal competency.

In addition, many of these measurements are made during non-speech activity such as blowing or sucking, and individuals with incompetent closure can sometimes perform these activities satisfactorily utilizing lingual-palatal contacts.

The problems associated with simple devices do not negate their use providing the clinician realizes the possibility of artifacts, especially in the borderline incompetency range.

Recognition of these problems has led to the development of more elaborate, complicated and expensive instruments for objective evaluation of cleft palate speech. The basic components of the aerodynamic measuring systems are flowmeters which record volume rates of airflow and pressure transducers which record airway pressures within the vocal tract. Used individually, these instruments are subject to the same inaccuracies as the less expensive devices. For example, flowmeters have been used to estimate velopharyngeal competency under the assumption that nasal airflow is linearly related to palatal function. However, there is good evidence that this assumption is not true. The same problem of contamination by compensatory phenomena is present with these instruments when used alone.

When flowmeters are used in conjunction with pressure transducers, velopharyngeal function can be separated from the influence of compensatory adjustments by other vocal tract structures. Hydraulic equations have been used to measure such parameters as velopharyngeal orifice size, nasal airway resistance, oral port opening, and the timing of consonant production in order to identify the compensatory adjustments, most often maladjustments, which occur in response to incompetent closure.

The advantage of techniques which directly measure the size of the sphincter is obvious, since this is precisely the information that the surgeon should know. Comparison of preoperative and postoperative speech samples is not an effective method of evaluation, since poor articulation may remain even after successful surgery, thereby masking the surgical result.

The drawback to this approach is that the instruments are more complex than the average clinician desires, and a compromise between simple devices and sophisticated techniques is desirable. This means that a manometric instrument should be simple to use, inexpensive, and able to delineate palatal function from other articulatory influences. The solution is to use an instrument which records the difference between oral and nasal pressures during plosive consonant production, such as the /p/ sound. A zero pressure obtained with this differential pressure transducer technique means that the palatal function is so minimal that pressure in the nose equals pressure in the mouth, or there is no functional separation between the cavities. As the palatal mechanism improves in its ability to achieve closure, the pressure
difference rises. Utilizing this instrument during production of plosive consonants eliminates the effects of tongue and mandibular position, since the oral cavity under these circumstances encloses a stagnant column of air. Similarly respiratory effort would have no effect since a difference in pressures, both influenced by effort, is involved. This allows the surgeon to evaluate palatal function directly, rather than recording some indirect parameter somewhat related to the individual’s speech performance. Limiting assessment to the palatal sphincter is the only valid way the surgeon can judge his specific contribution to the speech habilitation process.

Postoperative suction test

There is an immediate postoperative test which is a reverse aerodynamic challenge of the velopharyngeal seal, used for many years by a multitude of surgeons to estimate the effectiveness of the palate surgery and predict the eventual, or potential, velopharyngeal closure. In 1972 David Sullivan of Spokane wrote about this palate suction test:

The suction test, which I learned from Mr. Moore and which I find very useful, may not be original with him. A metal suction tip is introduced well back in one nasal cavity, then the hole in the suction tip and both nares are occluded while watching the velopharyngeal opening from the oral side. In a positive test the soft palate, posterior pharyngeal wall, and the sidewalls of the nasopharynx are quickly and readily pulled together to form an air-tight seal. This test is carried out before starting the operation. Presumably if it were positive at that time, there would be no indication for the operation. In practice, the test is always negative. If, after surgery, the test is positive, the surgery is over.

This is indeed an excellent guide and, although I have been using the suction test for years, I cannot say who first used it.
**Fluoroscopy by Borel-Maisonny**

In 1948, I had the unique opportunity to visit Victor Veau’s Hôpital Saint-Michel and to talk with his speech pathologist, as reported in “Plastic Peregrinations,” 1950.

No one is in a better position to judge Veau’s palates than the devouée Madame Borel-Maisonny, his speech therapist for twenty-five years. Often as early as two weeks following surgical closure of the palate, Madame Borel evaluates the result. A 20 cc. syringe of liquid barium is injected into the naris, thus coating the nasal surface of the palate. With the patient’s profile under fluoroscopy, the different positions of the palate during certain fundamental sounds are marked on tracing paper. It is possible for Madame Borel to predict the prognosis of each palate, prevent adenoidectomies when that excess tissue is needed, prescribe obturators when the palate is insufficient in length. She says she has been able to obtain normal speech results in 74% of Veau’s palate cases. In some of these cases it was necessary to fit an obturator against the pharyngeal wall for the short but mobile palate to play against for normal speech. Then there were always the few short and scarred palates from which normal speech can never be formed.

It is interesting that 25 years later there was only a 1 percent improvement over Veau’s palate results. In 1973 Hughlett L. Morris of the University of Iowa reviewed the literature between 1960 and 1971 to determine the percentage of patients with velopharyngeal competence, as judged by "speech results" following primary cleft palate surgery. He concluded:

> A success rate of 75% seems reasonable in estimating the velopharyngeal competence results from primary cleft palate surgery, although it is apparent that the success rate is influenced by many factors.

**Yules**

In 1968 in *Plastic and Reconstructive Surgery* Richard B. Yules, while still a resident, with William H. Northway, Jr., and Robert A. Chase of Stanford University School of Medicine, reported quantitative data accumulated from routine sound cinefluorography of 68 cleft palate patients, 24 velopharyngeal incompetent patients and 34 controls. A standard speech test was used, consisting of vowel and consonant sounds, single words (designed to test linkage of vowel and consonant sounds), connected speech,
spontaneous speech, blowing and swallowing. Lateral studies were performed by single-frame and sequential-frame analyses, utilizing a Kodak cine-analyzer projector. Measurements were determined directly from the image projected onto a paper screen and corrected for the magnification present in each frame, as indicated by the metal marker disk. Eight separate measurements were determined:

(1) HPA: the hard palate to atlas distance of the posterior nasal spine (pns) to the mid-anterior atlas (pns-g)
(2) HPP: the hard palate to posterior pharynx distance, or distance along a line drawn through the anterior (ans) and posterior nasal spine to the posterior pharyngeal wall (pns-e)
(3) SPL: the soft palate length, or distance from the pns to the soft palate tip (pns-a)
(4) EPL: the effective palate length, or the length of the soft palate in the plane of velopharyngeal closure (pns-f)
(5) SPT: the soft palate thickness taken perpendicular to the SPL line at its thickest point (l-m)
(6) RDUP: the resting distance from uvula or soft palate tip to the pharynx, taken on a line parallel to the HPP (a-d)
(7) QDUP: the distance of the uvula from the pharynx when the soft palate was maximally stressed for velopharyngeal closure, i.e., while saying the word “quack” (b-c)
(8) RDPA: the resting distance from the pharynx to the atlas, taken from the point of closure or expected closure on the posterior pharyngeal wall to the atlas (f-g)

No statistically significant differences in measurements were obtained by age or sex grouping. Certain other important differences were, however, noted:

Control soft palate length was shown to be longer than in cleft palate and velopharyngeal incompetent patients; hard palate to pharynx distance was increased in velopharyngeal incompetent patients, compared with controls and cleft palate patients. . . . Routine sound-synchronized ciné-radiography is in itself dramatic in a descriptive sense; it will become most useful when it is quantified to the extent that the surgeon may choose from a given set of operations and a speech therapist choose his therapy from quantitative data which will allow prognostication.

993
Berkowitz

For years Sam Berkowitz has been carrying out lateral cephalometric evaluation of velopharyngeal function in our cleft palate clinic. Here are some of his 1977 comments:

Cephalometric roentgenology has contributed static and dynamic data of interest to the speech physiologist. It has been utilized to study variations on the depth and configuration of the oral and pharyngeal cavities, and in the measurement of the adenoid and soft palate. Understanding the dynamics of growth and development of the nasopharyngeal spaces and their contiguous organs is essential for a proper evaluation of the speech mechanism. Many studies have emphasized the need to appreciate the structural variations that

Incompetent velopharyngeal closure

At rest—velum lying on dorsum of tongue

Vocalizing "Yauuu . . ." velum elevates but fails to make contact with adenoid

Incompetency due to velar paralysis

Neuromuscular malfunction evidenced by failure of soft palate to elevate while phonating "Yauuu . . ."
might exist in the intra-nasal and pharyngeal architecture of infants with various clefts of the lip and palate.

The lateral cephalograph is an excellent diagnostic tool to assess the capabilities of the patient to perform proper velopharyngeal closure in the anteroposterior dimension. It has permitted the clinicians to appreciate the significance of the variations in the dimensions of the pharynx and pinpoints those factors which determine the success or failure in obtaining proper airflow control and which might be beyond the influence of the surgeon’s skill. It is impossible to assess velopharyngeal closure by preoral examination due to the abnormal posture of the head and the line of visual inspection. It has been stated that cephalometric films can provide single point-in-time estimates of velopharyngeal function that agree rather well with cinefluorographic observations with sounds \( s \) and \( u \). It appears possible to make meaningful generalizations concerning dynamic aspects of speech from cephalometric data.

Three head plates are taken: one at position rest, the second during sustained phonation of the vowel \( u \) ("Youuu. . ."), and the third while saying \( s \) ("ss. . ."). These films reveal information related to:

- Vocalizing \( u \)
- Vocalizing \( s \)

Stretch reflex: the ability of the soft palate to increase in length during function.
Left. Incompetent closure when vocalizing "Youuu. . ." Right. Soft palate now makes contact when vocalizing "ss. . ." because of its increase in length. These patients are amenable to speech therapy and need not have palatal surgery unless all else fails.

1. length of velum at rest and in function
2. variations in the skeletal framework that determine the outlines of the nasopharynx
3. relationship of the adenoid tissue to the nasopharynx
4. the neuromuscular functional capabilities of the pharyngeal musculature.
Nasopharyngeal Configuration

Velopharyngeal valving is dependent not only on the sensory-motor adequacy of the velum and synergistic musculature, but also upon the morphologic dimensions of the nasopharyngeal port. The size and shape of the nasopharynx is determined by the contiguous osseous anatomy of the maxilla, cranial base and vertebral column. Various anomalies of the cervical vertebrae, such as fusion of C2 and C3, occipitalization of the atlas, malfor-

![Diagram of cervical vertebrae](image)

malformation of the anterior tubercle of the atlas, and malposition of the atlas, increase the pharyngeal depth and are often seen in patients with congenital palatopharyngeal incompetence (CPI).

Malformation of the atlas associated with an increase in the AP pharyngeal dimension. Pharyngeal flap used to correct velopharyngeal incompetence. Note: Posterior pharyngeal wall being pulled forward during function.

Variability of the Anteroposterior Pharyngeal Dimension

Ricketts demonstrated that problems in the cranial base and skeletal structures, rather than in the palate alone, can be responsible for cleft palate.
speech. Deep retropharyngeal dimensions are often coexistent with obtuse cranial bases which distally position the cervical spine relative to the maxilla. He demonstrated that there can be cleft palate speech if there is a deep retropharynx with or without adenoid tissue. Yet, in another case, without adenoid tissue but with a shallow retropharynx (due to an acute cranial base which brings the cervical spine closer to the maxilla, and/or due to an exceptionally large anteroposterior maxilla), there might be normal speech. The utility of the adenoid tissue in velopharyngeal closure is related to the overall dimensions of the nasopharynx. If the adenoid is exceptionally large and/or close to the posterior nasal spine of the maxilla, it may block off the posterior nasal choanae and cause nasal atresia with denasal speech.

As the face grows, the palatal plane (pp) descends away from the anterior cranial base (NS), affecting the pharyngeal depth. This dimension increases with growth. (Berkowitz, S.)

Subtelny has demonstrated that the AP pharyngeal dimension increases with growth and the soft palate has to span a greater distance in order to make contact. Hypernasality, therefore, can occur at a later date with or without adenoidectomy.

Atrophy of Adenoid Tissue

T.B.
- Age 9
- Age 13
- Age 25

Subtelny
Not all cleft palates have inadequate velopharyngeal function. The pharyngeal dimensions are not related to the cleft type, but are influenced by the effects of surgery.

Adequate velar closure in bilateral cleft lip and palate due to a very well-developed maxilla coupled with a very shallow pharyngeal space is shown. Although this dimension increased slightly in six years, velar closure remained competent.

Mid-facial hypoplasia was brought on by non-physiological surgery. Maxillary size was reduced in all three dimensions, resulting in an anterior dental crossbite, erroneously diagnosed as being due to an oversized mandible. Failure of the maxilla to develop in the anteroposterior dimension increased the depth of the pharyngeal space, causing velopharyngeal incompetence.

The Pharyngeal Flap Procedure

Many excellent reports support the continued use of this procedure for the correction of hypernasality. It has been our experience that a wide superiorly based flap is the surgical procedure of choice, especially when the palate is scarred.

Case A

Velopharyngeal incompetence seen when vocalizing "Youuuu..."

After surgery; note pharyngeal wall being pulled forward
Incompetent closure on vocalizing "Yoonu..."

After surgery; posterior pharyngeal wall being pulled forward during function

Video fluoroscopy

M. Leon Skolnick of the University of Pittsburgh has achieved a breakthrough with a multiview videofluoroscopic technique. He reminisced in 1977:

According to my medical school classmates, I chose radiology in order to pursue my favorite hobby, photography, so that I could continue to enjoy my love of highlights and shadows. I became involved in radiographic studies of speech shortly after I arrived at the Upstate Medical Center in Syracuse, New York, in November, 1967. The radiology department had been providing lateral cine studies of cleft palate patients but none of the radiologists were interested, so, as the newest member of the department, this task was given to me like a hot potato. I began to attend the weekly conferences of the cleft palate clinic and, as a result, a growing rapport developed. I am indebted to plastic surgeons David Stark and Alfred Falcone and speech pathologist Gerald McCall for their interest and encouragement.

Soon I began to realize the limitations of lateral cine studies. These studies were initially performed without barium and the soft tissue detail was often poor. Specifically, one could not always tell whether closure was occurring or whether a small gap was present. In addition, though the children were speaking, these were silent cines. We had no way of indicating what sounds the patients were producing as the films were taken. While searching for ways of recording sound and roentgen images simultaneously, I happened upon a beautiful and dust-covered 2" Sony video tape recorder, then a microphone, and lo and behold, I could record roentgen images and speech simultaneously on video tape! In addition, since I was able to play back the images immediately, I wheeled the video recorder into the cleft palate clinic to show the physicians the results of studies performed the same...
day. What a fantastic effect this had on everyone! Now I too could participate in the clinical evaluation of the patients and present my findings, the fluoroscopic study of the pharynx on video tape. Often lively discussions ensued because the clinicians observed one thing intraorally and I demonstrated something different videofluoroscopically. They began to realize the limitations of their physical examination and place more value on the fluoroscopic study.

A major source of information that was not provided by the lateral film was information on movement of the lateral pharyngeal walls. The need for this information was stressed by the plastic surgeons. I settled on barium as the best contrast agent because of its acceptance by the patient and excellent coating. Initially, after examining sagittal specimens of cadaver head and neck, I realized that the view that would visualize the palate and pharyngeal walls at one time would be one looking down through the velopharyngeal portal. I first obtained an intact head and sectioned it in a transverse plane just above the hard palate to visualize the plane of the velopharyngeal portal more carefully, and then had to devise the optimal patient positioning for this view. Obviously, one needed a cooperative subject who would tolerate holding a variety of uncomfortable positions so that I could determine which would be most satisfactory—my wife, Irene! By the spring of 1969, the base view was born and soon perfected. One comment about my presentations at national meetings is in order. Except for my first paper presented at the Radiologic Society of North America in December, 1968, all my subsequent presentations were at cleft palate or plastic surgery meetings. Several papers submitted to national radiological meetings were rejected. In the radiological field, I was somewhat of a peculiar fellow.

In 1969 Skolnick used videovelopharyngography in patients with nasal speech with emphasis on lateral pharyngeal motion in velopharyngeal closure. In 1970 he used videofluoroscopic examination of the velopharyngeal portal during phonation in lateral and base projections. In 1972 he studied velopharyngeal competence and incompetence following pharyngeal flap surgery with videofluoroscopy in multiple projections. Finally, in 1973, with McCall and Barnes in the Cleft Palate Journal, he described the various patterns and configurations that the sphincteric mechanism exhibited in a group of 85 non-nasal and nasal subjects without pharyngeal flaps. These patients were studied with his multiview videofluoroscopy (lateral, base and frontal views) after the nasopharynx was coated with barium.

Skolnick presented a schematic view of the normal pharynx showing the sphincteric mechanism of velopharyngeal closure.
from the lateral, frontal and base radiographic projections. The dotted lines represent the velum and pharyngeal walls at rest; the heavy solid lines show the same structures during velopharyngeal closure. Skolnick noted:

Observe on the lateral view that the velum elevates and elongates posteriorly during phonation. . . . It should be emphasized that the frontal view is useful because it best demonstrates the vertical extent of the pharyngeal portion of the velopharyngeal sphincter. However, the base view which permits visualization of the portal en face is required to appreciate the total sphincteric concept of velopharyngeal closure.

Skolnick also presented sketches of sphincteric closure of the velopharyngeal portal in a normal subject seen from base view, presenting the portal at rest (A), during partial closure showing a coronal pattern developing as the velum moves posteriorly and the pharyngeal walls contract centrally (B), and at full closure producing a coronally oriented slit (C).

In both non-nasal and nasal subjects, Skolnick found multiple patterns of sphincteric closure. The multiple patterns result from variations in the relative contributions of the velar and pharyngeal movement components to the closure mechanism. His diagramatic outline of the VP sphincter presents the velopharyngeal portal at rest (on the left), at partial closure (in the middle) and at full closure (on the right).

A portrays a normal subject showing convex projection of the uvula portion of the velum into the velopharyngeal portal at rest.

B presents a postoperative cleft palate showing absence of the uvular muscular bulge at rest, with a coronal pattern of closure similar to the normal.

C shows a postoperative cleft palate with circular closure pattern.
He concluded:

However, it is clear that multi-view video or cinefluorography offers an adequate approach for the examination of the sphincteric mechanism of velopharyngeal closure. It behooves us to begin taking the necessary steps required to incorporate this roentgen procedure into our clinical protocol if at all possible. Therefore, think sphincter!

In 1975, with Shprintzen, McCall and Rakoff, Skolnick examined in multiple videofluoroscopic projections 30 postoperative cleft palate patients (2 to 12 years of age) with normal speech to assess velopharyngeal closure in three dimensions. They found:

1. All 30 subjects exhibited contact between the superior border of the velum and the adenoid mass in the nasopharynx. . . .
2. All 30 subjects showed good localized medial movement of the LPW at the appropriate plane of the hard palate.
3. 10 out of 30 subjects, 33%, had a Passavant’s Ridge during speech. All 10 of these subjects utilized the ridge as a point of closure, as well as the adenoids.
4. The observed patterns of closure were consistent across varied consonant utterances.
5. The mechanism of velopharyngeal closure in this group of subjects is essentially the same as for normal adult speakers and differs only anatomically due to a lack of head growth in children.

In 1977, upon request, Skolnick forwarded some photographic illustrations of his multiview fluoroscopic studies of cleft palate:

D shows a postoperative cleft palate with circular closure pattern and Passavant’s ridge. (Ridge is represented by stippled and lined area in middle and right columns.)

E shows a postoperative cleft palate with sagittal closure pattern.

Skolnick’s stinging logic emphasized:

The articulatory and resonance characteristics of a patient’s speech are valid indicators only of (1) the presence or absence of velopharyngeal incompetence and (2) the consistency or inconsistency of the incompetence. The speech symptoms provide no information about the precise defects in a patient’s velopharyngeal mechanism that is producing his incompetence. We believe it is vital to know these precise defect(s) in a given patient’s velopharyngeal closure mechanism prior to undertaking procedures to correct the abnormalities producing the deviant speech, whether by surgery, prosthetic devices or speech therapy. Only by this means can the treatment be adequately tailored to the needs of an individual patient and the results then objectively assessed.

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In 1977, upon request, Skolnick forwarded some photographic illustrations of his multiview fluoroscopic studies of cleft palate:
Lateral and base views of repaired cleft palate with coronal type of velopharyngeal insufficiency on base view.

Patient with pharyngeal flap who demonstrates bilateral incompetence after surgery. Lateral and frontal views during quiet breathing (B) and phonation of \( e \) (e) are presented. Note on the base view that even with phonation, both lateral portals remain open.
Lateral and base views of patient after pharyngeal flap with unilateral portal incompetence. B represents quiet breathing; e represents phonation of this sound. Note on the base view that the left portal completely closes and the right portal, though reduced in size, still has a small opening through which air escapes.

Lateral and frontal views during breathing (B) and phonation of e (e) of a repaired cleft palate in a patient with velopharyngeal incompetence. No pharyngeal flap is present. On base view during phonation, portal decreases in size, but a large coronal defect remains.
Lateral and frontal views of patient with a pharyngeal flap during breathing (B) and phonation (S) who demonstrates satisfactory closure of the portals on either side of the flap. The base view during breathing demonstrates a central narrow flap and bilateral open portals. During phonation the portals close against the edges of the flap. Arrows indicate the open portals during breathing. Arrowhead indicates position of flap during both breathing and phonation.

Lateral, frontal and basal views during breathing (top row) and during phonation (bottom row) of normal subject. During phonation velum elevates and touches posterior pharyngeal wall on lateral projection. On frontal projection localized medial movement of lateral pharyngeal walls is seen in nasopharynx (horizontal arrows). On base view the barium-marginated oval seen during quiet breathing centrally contracts to close the velopharyngeal portal in a coronal closure pattern. Arrows indicate the region of the closed portal. Barium lateral to arrows represents barium squeezed above and below the level of the portal during closure.
EN D O S C O P Y

Of course, the best method of studying the function of the velopharyngeal sphincter during speech would be under direct vision. Although this has been possible in rare cases after removal of a portion of face and maxilla during extensive tumor ablation, such action is a bit radical for routine postoperative cleft palate evaluation. The next best view of the sphincter is offered by endoscopy.

Oral

According to Pigott, Madame Susanne Borel-Maisonny of Paris published findings of oral endoscopy in cleft palate in 1937. In 1966, in the *Cleft Palate Journal*, Stanley Taub of Brooklyn, New York, a self-taught ventriloquist with a natural interest in the mechanisms of speech, reported that in 1962, as a resident at Kings County Hospital, he had developed the oral panendoscope. This instrument is an integrally illuminated, tubular optical device with a lens system which increases the light transmission from the objective prism to the viewer and camera at the proximal end. A high-intensity incandescent lamp adjacent to the objective lens illuminates the target surfaces at proper levels of light, as required for direct observation, motion picture and still photography. An eyepiece is provided with a glare shield for clinical use and a threaded adapter for camera mounting. A nylon removable tongue depressor functioning as a heat shield is fitted to the instrument. The oral panendoscope is inserted into the oral cavity with the objective lens up and is manipulated for viewing the posterior pharynx and nasopharynx. The muscular activity of the palatopharyngeal sphincter mechanism is clearly observed while the patient recites various combinations of vowel-consonant-vowel sounds. The mouth may be closed with the instrument inside, providing visual observation during phonation. Excited by the visualization of the nasopharynx, Taub exclaimed:

My joy at viewing this area could be compared to looking at the dark side of the moon!

and concluded:
The Taub oral panendoscope . . . creates the opportunity for improved diagnosis, treatment and research, by providing a tool and method for simultaneous visual observation and audio-visual recording of the operation of the speech mechanism during the production of speech sounds in normal and abnormal subjects.

Nasal

Ronald W. Pigott, a deft left-handed, imaginative and artistic Irishman who played hockey for Ireland (British Combined Services) and tennis for the University of Dublin, came to the University of Miami in 1967 as a Robert W. Johnson Fellow. He became interested in the direct visualization of the velopharyngeal sphincter. The versatility of fiberoptic instruments opened new possibilities when, finally, the American Cystoscope Company's Infant Urethroscope (overall diameter 3 mm.) was found suitable to pass through the infant's nostril. With University of Miami speech pathologist Jack F. Bensen as an educated subject, Pigott, in 1969 in Plastic and Reconstructive Surgery, presented his method of nasendoscopy utilizing 1% cocaine spray. The "patient" lay in a semi-recumbent position in a dental chair equipped with a headrest so that the surgeon could be positioned as in surgery. Speculum exposure allowed the scope to pass gently into position, and mucus was suctioned until the posterior border of the soft palate and the posterior pharyngeal wall can be seen 1-3 mm before the tip of the instrument contacts the posterior wall.

Bensen went through standard test phonetics on 25 normal subjects ranging from 11 to 45 years of age while Pigott observed the palate and pharyngeal walls and noted the following:

At rest
1. The enormous bulk of the musculus uvulae could be seen. The majority of subjects had a large ridge down the soft palate . . .
2. The levator sling can be detected . . .
3. The side of the ridges of the salpingopharyngeus varied enormously.
4. The eustachian orifice could be examined easily. Occasionally, movements inside it could be seen, with opening and closure of the tube . . .

During Speech Movements
Extremely rapid movements were made. The levator sling could be seen to tighten into a bar, throwing the convexity of the musculus uvulae bulge
up and back to fit into the concavity of the posterior superior pharyngeal wall. In normal rapid speech, almost no lateral or posterior wall movements seemed to occur. Sometimes the levator ridge hardly seemed to contact the pharyngeal wall, but the contracting musculus uvulae flipped the passive free margin of the palate back into contact, where it stuck momentarily to the pharyngeal wall, before dropping away (as the levator relaxed). The lateral gutters (noted in 1880 by Falcson and confirmed from below by Taub) were occasionally seen . . . sometimes leaving a gap apparently 2-3 mm in diameter. . . . These lateral gutters were blocked by medial movement of the salpingopharyngeus in many subjects, though escape of air below the level detectable by ear has been found by Bjork and Nylen and by Warren.

As nasendoscopy allowed unobstructed observation of the nasal surface of the velopharyngeal valve without interruption of speech, Pigott, with Bensen and White in 1969, was able to report interesting findings and treatment suggestions in velopharyngeal incompetence. Asymmetrical velopharyngeal closure suggested a pharyngeal flap on the open side; a pharyngeal flap ineffective on one side called for a second flap on that side; midline gaps suggested pharyngeal flaps; the lack of a salpingopharyngeal fold and poor lateral gutter closure suggested a Hynes pharyngoplasty. One pharyngeal flap, appearing narrow to the surgeon but presenting normal speech to the pathologist under endoscopy, was shown to be broad above, leaving slit-like orifices which closed with mere palate flicking, proving that an adequate flap reduces the velopharyngeal opening to a size controllable by meager palate movements. Light palate contact against large obturator suggested gradual reduction in size of obturator or quicker improvement with a pharyngeal flap; pushbacks with island flaps showed mobility, normal speech and firm closure if the island had blended imperceptibly with the surrounding tissues, but examples of partially extruded islands indicated need for through-and-through sutures between the island and mucoperiosteal flaps during surgery. Inconsistent closure, but with mechanisms for consistent closure present, offered a good case for postponement of surgery. Pigott also noted the high percentage of almost completely atrophic musculi uvulae in these patients, coinciding with Broomhead’s finding that the lesser palatine nerve serving this muscle is routinely cut in pushback operations.
when the aponeurosis is freed from the edge of the hard palate. This emphasized the importance of trying to preserve these nerves during the dissection.

At Frenchay Hospital, Bristol, Ron Pigott continued to develop his nasendoscopy, properly renamed “nasal pharyngoscopy” by Huffstadt of Gröningen. He was joined by A. P. W. Makepeace of the Audio-Visual Aids Unit, University of Bristol, whom Pigott describes as

an audiovisual eccentric, a scientific magpie who knows more sciences and medicine than one would believe possible without a degree. He devised the split screen videotape recording.

In 1975, in the *British Journal of Plastic Surgery*, Pigott and Makepeace described their technique of recording nasal pharyngoscopy to aid memory and improve clinical care and research. Improvement in topical anesthesia was achieved by an intravenous cannula with a wisp of cotton wool held on to the tip with Micropore tape and saturated with 4% lignocaine. Most children over 8 years old were found to cooperate. The Storz-Hopkins nasopharyngoscope was introduced somewhat as previously described.

In recording sessions the endoscope coupling is fixed to the endoscope eyepiece before the procedure starts and the Lavalier microphone suspended by a cord round the patient’s neck. . . . The television camera, suspended in a simple gimbal and coupled to the suspension shackle by a snap hook is advanced so that the magnetic coupling can find its automatic location on the eyepiece. . . . With a minimal movement of the head the examiner can watch the monitor while a videotape recording is made, in this case simultaneously with the lateral pharyngeal X-ray.

Pigott tests forced closure on *pah-pah-pah, tab-tah-tab, sah-sah-sah*, and then asks the patient to count up to 20 quickly. He notes:

Where closure is achieved on the isolated tests, it may be deduced that the potential of speech education exists. Failure of closure will be seen on rapid counting especially in the second 10 when muscle fatigue and loss of concentration often expose weakness. Total, central, bilateral or unilateral defects may be noted. Movement may be present in all walls, any or none, and the operative plan should take account of this.
In the 1975 *British Journal of Plastic Surgery*, B. C. Sommerlad, E. J. Hackett and J. Watson of the London Hospital and St. Andrew’s Hospital, Essex, presented a simplified method of recording. They noted:

The endoscope about to be introduced is connected by the fibre-optic teaching aid to the special lens on the camera (on stand) and by a twin fibre-optic light cable to the light source (on the left of the picture). The videotape recorder with its small attached screen is beside the light source.

They concluded:

In view of Pigott’s work, it would appear that a pharyngoplasty without prior pharyngoscopy is similar to an operation on the bladder without cystoscopy. Now that a simple method of recording . . . is available, we hope nasal pharyngoscopy will become a routine examination in patients with speech defects.

In 1977 Pigott acknowledged:

Recording is now facilitated using fibre-optic teaching attachment between television camera and endoscope as suggested by Sommerlad and Hackett. This has been a big step forward and means that any patient who can be endoscoped can be recorded. . . . Failure to endoscope patients over twelve years of age is negligible. Between eight and twelve, success rate is about nine out of ten, and between three and eight years, about three out of four. The youngest children who find cooperation for endoscopy most difficult do well with basal x-ray assessment. Yet not all patients have flexible enough necks to achieve correct position for basal studies and these are the older patients easier to scope. Mucus coated with barium creates serious artefacts occasionally which leads to the wrong diagnosis. Whenever possible, both endoscopy and x-ray should be used.

At the 1975 International Congress in Paris, I challenged Pigott to get me action photographic records of various methods with his nasopharyngoscope. At the 1977 International Cleft Palate Congress in Toronto, where he was giving a seminar on nasopharyngoscopy, he presented me with the coveted photographs which are displayed with captions in the margin. Pigott summarized his 10-year experience:

Some specific observations are:

- Flaps don’t always stay the size they are cut and their base migrates.
- Orifices don’t always stay the size they are left. So, accurate planning is
wishful thinking in many cases. Successful flap cases leave relaxed ports far smaller than the normal isthmus so nasal resonance is adversely affected. No successful pharyngeal wall implant case has yet been recorded by me for a defect greater than 0.5 cm. By success, I mean that there is no nasal escape. I do not accept "improvement" as "success" because of the difficulty in grading, whereas it is relatively easy to say there is, or is not, nasal escape.

It is not true that audible nasal escape ceases below a port size of 20 mms. Passavant’s ridge is a stress phenomenon which disappears with adequate palatal lengthening. I suspect but cannot prove that the lateral wall movement of so-called normal speakers is also a stress phenomenon in compensation for minor degrees of pharyngeal disproportion.

Pharyngeal disproportion exists at the same time as cleft palate. So highly competent surgeons doing excellent standard repairs will find to their chagrin that the palate, though mobile, is incompetent, just as isolated pharyngeal disproportion palates are incompetent.

Why not do primary pharyngoplasties? Well, they have their disadvantages. Reduced nasal resonance, catarrh. They don’t always “work.” They increase the operative time and anyway, most experienced surgeons achieve 80% +/− 10% palatal competence without. What we need is to recognize pharyngeal disproportion. So far as I know we still cannot be sure which is which.

What benefit have I had from ten years of fairly intensive experience in this field?

1. Speech Assessment: I see what I hear. The visual feedback finds me in a strong position to know what nasal escape sounds like. That is to say, if the
Isthmus is firmly shut, what I'm hearing is NOT palatal incompetence and I can state that more objectively than the speech therapist and back the statement with a video tape. It is not infrequent for articulatory faults of cleft palate speakers, such as glottal stops and velar fricatives, to be thought synonymous with palatal incompetence. This is unfortunate because it leads to disappointment that a given pharyngoplasty does not "cure" articulatory fault habits. At best it merely paves the way. Surgeons, trainees, parents, patients (and even an occasional speech therapist) do not always understand this. So people continue to report "speech" and intelligibility improvements as the result of pharyngoplasty, not palatal competence—surely muddled thinking. Or, it may be a failure to realise that this is a simple valve which is open or shut; air does or doesn't go up the nose at the wrong time, and is or is not audible.

2. "Best Buy" Pharyngoplasty: In my experience the majority of defects are reasonably symmetrical. About five out of six have enough lateral wall movements for closure of the lateral ports against a good pharyngeal flap. About five out of six, not necessarily the same ones, have enough soft palate lift to close if the palate and pharyngeal wall are brought near enough to each other. About two-thirds have a closure defect of the central third of the relaxed orifice and of these, about a quarter have only a gulley in the midline, equivalent to atrophy of the musculus uvulae (which is never well developed in the cleft palate patient). Of the remainder, about a sixth have a defect of two-thirds of the relaxed orifice and about a sixth have a total lack of lateral wall adduction. Of these it has occasionally been noted that midline contact is achieved, but lateral gutters remain patent. The ideal technique should therefore be most effective in ensuring midline closure. Lateral flap techniques such as Hynes, Orticochea and Moore are least effective in blocking the midline defect. Implants are not very reliable so far in the deeper failure to close, but may be effective for small depth defects.

I have no experience of the Dorrance or Cronin palate lengthening procedures. The so-called Veau-Wardill-Kilner procedure was shown by Calnan to be successful in lengthening the palate to only a minor degree. Many cases will already have had this done. I am very doubtful if repeating it gives further length. Millard's island flap, brilliant in concept, is oddly disappointing in practice. A thick plug of mucus persists on its upper surface causing chronic catarrh. It seems to make the palate too thick and reduces mobility, and it is possible that peripheral scar contracture is responsible. However, it too can be successful in correcting incompetence and can be invaluable where pharyngeal wall has already been used without success.

Pharyngeal flaps have the potential for success in about five out of six cases (in which lateral wall movement is adequate, excluding technical faults). Those attached to the trailing border (inferiorly based) or to levator
eminence (standard superiorly based) tend to reduce the amplitude of the elevation. They simply obturate the central area while the lateral walls adduct against them.

The combination lengthening operation with pharyngeal flap inserted into the nasal layer near the back of the hard palate and well forward of the levator sling does not seem to reduce the palate lift; in fact it sometimes increases it and the pharyngeal flap pedicle may then be seen to be redundant on endoscopic examination. Examples of this technique are the Hönig modification of the superiorly based flap and the Millard T flap, and if one did not have adequate facilities for pre-operative assessment, it is my present feeling that this operation more than repays the extra time of retroposing of the palate. The lateral wings of the Millard T allow essential lengthening up to the pterygoid plates.

GRABB

William Grabb, trained by Dingman at the University of Michigan and following him as chief of the unit, is not only a fine surgeon but an exceptional organizer and a prolific writer. His training and experience in cleft surgery have rendered him both knowledgeable and discerning. His 1971 book, Cleft Lip and Palate, with Rosenstein and Bzoch, is the best and most complete work on the subject and has been the source of much material used or referred to in Cleft Craft. Grabb is completely sound, with his feet firmly planted on the ground—except, that is, when he is relaxing.

Dr. Grabb’s bag is Yankee Doodle, his red, white and blue hot-air balloon with a unique swing seat which looks like a wheel-less wheelchair. He has served as president of the Balloon Federation of America and has been in the air more than 150 times, flying low enough above the trees to pick leaves, and flying well enough to capture third in the 1968 Indianapolis Speedway Balloon Race, third in the Columbus International Balloon Race in 1969, second in the 1970 U.S. National Championships and first at Columbus in 1970. He once flew badly enough to land in a patch of poison sumac. When asked if he wrote his books while in the air, he admitted:

No, once up, I spend most of my time figuring how to get back down!

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In 1971 Grabb summarized the speech results reported in the literature during a 21-year period (1948-1968). The overall average speech of this group of 3,743 children who had operative closure of the palate cleft was normal in 71 percent of cases. Grabb also noted a definite trend of a higher rate of normal speech results in recent years, regardless of which operation was performed or who performed it.

In 1977 Grabb wrote about his University of Michigan cleft palate study designed to determine, in as objective a way as possible, which cleft palate operation or operations gave the best results. He outlined the research plan:

Beginning on January 1, 1971, some 90 children with cleft palate had the palatal cleft surgically closed by either: 1) staphylorrhaphy, 2) staphylorrhaphy and pharyngeal flap, 3) von Langenbeck palatorrhaphy, or 4) pushback palatorrhaphy with Cronin nasal mucosal flaps. The operation performed was determined in a random manner by drawing a slip of paper from an envelope. The operative technique has been carried out by a variety of staff and resident plastic surgeons following the explicit written directions and drawings in the Cleft Palate Study Syllabus.

The children with cleft palate in this study have had appropriate base line photographs, cephalograms, dental casts, and examinations recorded on the worksheet by the ear, nose, and throat physician and a plastic surgeon. These studies were repeated before each operation and will be repeated at ages 5, 10, and 15 years.

The 90 children in this study are divided into subgroups as to incomplete cleft palate, complete unilateral cleft palate, and complete bilateral cleft palate.

At the present time, the children reaching five years of age are being evaluated in regard to their speech, facial growth, and hearing. It is anticipated that at some time in the mid or late 1980's, preliminary results from this study will be reported. We do not have a computer system that will run off this data but rather it is stored in the form of dental casts, cephalograms, and worksheets in one central location. I hope the room does not catch fire.

DICKSON

David Ross Dickson, speech pathologist at the University of Miami School of Medicine and director at the Mailman Center for Child Development, has the ability to simplify speech nomenclature for the surgeon. He explained to us at one of our residents' conferences in 1978:
Vowels are formed by modifying the laryngeal sound in the pharynx and mouth. Low vowels may not reveal mild velopharyngeal insufficiency but high vowels will. Plosives such as \textit{t} and \textit{d} are created by stop and release with little pressure. Fricatives \textit{s}, \textit{z}, \textit{th}, \textit{ch}, are high pressure sounds formed by back pressure forced through a restricted area causing friction and heavy impedance. When there is a constant leak, not enough pressure can be generated to produce fricatives successfully.

Dickson brings all aspects of investigation and intervention into reasonable perspective:

It seems amazing, after all these years of research, how hard it is to sort out what we know from what we do not, and what is relevant from what is not. Also, it is most interesting how much information in this area has been contributed by professionals outside the field of speech. To me, this demonstrates that cleft palate assessment and treatment is truly interdisciplinary and not just multidisciplinary, since our best information has come from professionals from a number of disciplines working together and sharing ideas and constructive criticism. It is also clear that each professional must be interdisciplinary in understanding of the problems we confront to be effective. Certainly Pigott is right that “even” speech pathologists can confuse speech attributes which are not related to velopharyngeal competence with those that are. One can be an exceptionally good speech pathologist and not understand cleft palate assessment, just as one can be an exceptionally good surgeon and not understand the problems of cleft repair.

A number of things have been brought out which I feel deserve emphasis. It should be too obvious to state at this time in our history that cleft palate is not a normal palate with a hole in it. There are physiological differences due at least in part to muscular deformities. As pointed out by Pigott, one of the most important (and most neglected) of these may be the lack of a functioning uvulus muscle. Also, there are extra-palatal morphological differences including the pharyngeal disproportion noted by Pigott and others. Work in our laboratory has demonstrated that at least in the mid-term fetus, pharyngeal and cranial base disproportions are significant in cleft palate.

The principal goals of assessment are first, to determine whether speech is adequate or inadequate; second, if speech is inadequate, whether the problem is related to velopharyngeal incompetence; and third, whether surgical intervention will be necessary. As to the first question (“Is speech adequate or inadequate?”), to date, our best instrument is a trained ear. A trained ear is one which is hooked on to an informed, experienced person capable of common sense and logical deduction. A trained ear is necessary, in part, to avoid confusion among hypernasality, hyponasality, and speech problems not causally related to current velopharyngeal dysfunction. The second
question had to do with whether an existing speech problem is related to velopharyngeal dysfunction. The assessment of velopharyngeal adequacy involves two factors: the movement patterns of the velum and pharynx, and the degree of velopharyngeal closure. The latter has been approached by Warren. Evaluation of velopharyngeal patterns of activity has been attempted by a wide variety of radiological procedures, by nasendoscopy, and by ultrasound. Use of ultrasound has not been fruitful. Nasendoscopy is difficult in young children and is often difficult to interpret due to the lost third dimension of vertical space. Radiological procedures, especially combined lateral and basal videofluoroscopy developed by Skolnick, though also difficult with very young children, seems to be the method of choice currently. However, even this procedure should be used selectively, not in grossly incompetent cases but rather in cases of marginal velopharyngeal adequacy. The bottom line in assessment is that you use the tools at your disposal efficiently. This means that if a patient walks in with a palate that is obviously extremely short and inactive and his speech is extremely hypernasal, it is not going to take a lot of fancy gadgetry to determine that he has an inadequate velopharyngeal mechanism. It’s the borderline cases that necessitate more involved evaluative procedures.

The third question was “Will speech therapy normalize speech or is surgical intervention necessary?” If velopharyngeal closure can be produced without excessive effort on occasional speech attempts, the patient is a good candidate for speech therapy, since there is at least a reasonable probability that the velopharyngeal problem is not due to structural or neurological inadequacy. If the patient does not achieve velopharyngeal closure on any speech attempt, it is unlikely that speech therapy is going to result in his being able to do so. Also, if the patient can just barely make velopharyngeal closure with maximal or concentrated effort, he will probably not be able to achieve closure with connected speech. Imagine yourself trying to use a typewriter with weights attached to your fingers. Imagine that those weights are so heavy that with all the strength you can muster, you can just barely move your fingers from one key to another. Now try high-speed typing (without any errors, of course). Another way of putting it is that you can’t expect a person who can lift a 500-pound weight to use it in his juggling act. Speech therapy may help the person who can’t get his act together but it won’t make up for a short or inactive mechanism.
For many years most cleft palate patients were operated on by general surgeons, dental surgeons or, if they were lucky, plastic surgeons, and that was the end of it. Merely by chance, the dentists faced the results, and occasionally a speech therapist was called in for aid. If, 23 years ago at Duke University, 65 percent of cleft palate cases had no orthodontia and 75 percent had no speech therapy, imagine what was happening in the hills of Tennessee or down in the Ozarks.

In the 30's, 40's and 50's, when St. Louis, with Barnes and Children's Hospitals of Washington University School of Medicine, was the American cleft lip and palate mecca, the surgeons totally ruled the handling of clefts. It would be somewhat chilling for me to visualize an orthodontist or a speech pathologist criticizing Barrett Brown's palate results or dictating his timing or choice of surgery. As I remember, Brown was so "busy" he could never have sat for several hours with a "team" listening to other specialists' opinion of his work. Thus, there was a one-way communication on the cleft cases, but that is not to say the aid of the dentist and the speech therapist was not sought. This is how Frank McDowell recalled those days:

When done successfully in one palate operation at 18 months, about two-thirds of these would spontaneously develop normal speech. About one-third had varying degrees of speech abnormalities—and they represented the real problem. The best solution to it was, we felt, via a careful speech analysis at about the age of 5 years by a speech pathologist who was a specialist in cleft palate speech problems. This person could then pinpoint the exact problems the child was having, prescribe the exact things the child needed to work on, then assign him to a specific teacher for individual
lessons to overcome these specific shortcomings. There were check-ups by the pathologist at about 6-month intervals to see how much progress was being made and which exercises could be dropped. This, together with skilled orthodontic care, got rid of nearly all (but not all) the speech problems. The main problem, of course, was in those children who came from a distance, who had speech problems, and who did not have these skilled personnel available to them. If it was only a couple of hundred miles, we insisted they make the trip every week.

There were also some dropouts—and one of our main functions was to try and get lackadaisical parents of children with speech problems to see how important this therapy was. Too often, for convenience, they would want to enroll them in their local school program—which was usually class therapy for stammering and made the cleft palate children worse. We had to fight this and get them to see that individual private lessons were more important than another car or another TV set.

TEAM APPROACH

In 1966 Robert H. Ivy reviewed the history of the team approach in the management of cleft lip and palate:

It is readily understood that in that period mentioned, the treatment of cleft lip and cleft palate was carried out in a very haphazard manner; almost every general surgeon had a part in it, in addition to a handful of men more or less qualified as specialists in the field.

In Pennsylvania, as time went on, certain dentists were manifesting a special interest in the dental problems involved. During these years, we began to hear more and more of Dr. Herbert K. Cooper of Lancaster, an orthodontist who had been confronted with the problem of handling many cases of unsuccessful surgery, and other cases where surgery had accomplished everything possible, but which still, to be complete, required extensive mouth rehabilitation. Some time around 1938, Dr. Cooper, in an effort to cope with some of the financial problems involved, sought and obtained the support of the Lancaster Rotary Club. Through his extraordinary talent in the professional and administrative fields, this venture culminated in the establishment of the Lancaster Cleft Palate Clinic.

At this time the secretary of health of the Commonwealth of Pennsylvania recognized that cleft lip and palate should be included in the State Crippled Children’s Program. It was also proposed that, as soon as feasible, besides surgery, the program should include general dental care, orthodontics, prosthodontia
and speech therapy. Meanwhile, at the Lancaster Clinic, the underlying philosophy of the present-day complete cleft palate management was being developed under the direction of H. K. Cooper. This was in the form of an integrated team approach by a group of clinicians representing the several interested specialties.

Since those early days, cleft palate teams have formed in most major medical centers with better overall care for the patient. It is interesting to follow to the end the method of habilitation developed by descendants of the St. Louis dynasty. One of the important organizers in the field of cleft lip and palate is William C. Trier, who is motivated toward the team approach because of the tremendously satisfying feeling that the patient with a complex problem is having all of his needs met.

Trier, trained by Brown, Byars and McDowell in St. Louis, reminisced in 1977:

My training in plastic surgery gave me an opportunity to observe the care of children with cleft lip and palate solely by the surgeon. Although there was telephone or written communication with the orthodontist and, I presume, the speech pathologist, there was no opportunity for even these three disciplines to meet together to diagnose, plan treatment, evaluate each case.

Trier returned to the U.S. Navy and found no cleft palate team there. In five years, when he followed Joe Connelly as chief of plastic surgery at the National Navy Medical Center in Bethesda, he retained the cooperation of orthodontist Peter Cocarro of NIDR and induced Jim Lore, speech pathologist and psychologist, to form a team. Upon retirement from the Navy, he joined Erle Peacock (also trained in St. Louis), who was chief at the University of North Carolina. Trier summarized:

Among other exciting things, this gave me the opportunity to join a first-class cleft palate team. This team had begun modestly when Erle recruited a speech pathologist, rented a house in Chapel Hill with a housemother, and conducted the first Summer Resident session for seven children. The kids were entertained royally by the townspeople of Chapel Hill, got rides on the fire engine, swam in the University pool and also underwent intensive individual and group speech therapy. In the following year, Don Warren joined the faculty in the School of Dentistry and he and
Erie established a real team with the various dental specialists, pediatric and ENT support and moved the program to Story Book Farm, a camp for children on the outskirts of Chapel Hill.

There are two basic operational elements to the program. The first is a diagnostic and evaluation aspect including dental, plastic surgery, pediatrics, otolaryngology, psychology, speech pathology and social services study. The patients are presented at a weekly conference attended by all the disciplines where a summary of their findings and recommendations are presented and plan of treatment decided. I then meet with the family after the conference and outline the plan for the child.

The other major element to the program is the resident sessions held each spring and fall. The Chapel Hill school district provides a full-time school teacher who conducts an intensive academic program providing individual intensive speech treatment each week for the ten-week session. Many of the children also receive needed outpatient dental treatment during the resident session and frequently secondary surgical procedures are performed at the end of the session or even far enough in advance of the session to allow its evaluation.

**MIAMI TEAM**

Miami formed one of the relatively early cleft palate teams in 1951, when prosthodontist Cloyd Harkins came and lectured at Lindsay Hopkins Educational Center on the value of prosthetics to postpone palatal surgery. After this, the South Florida Cleft Palate team was formed and led by prosthodontist Norman Alley, including pedodontist Herman Anderson, orthodontist Robert Litowitz, pediatric surgeon Robert Dickey and, later, speech pathologist Betty Phillips. After a few years, prosthodontist George Balber became chairman and the clinics were held at Variety Children’s Hospital. In 1968, when Balber resigned, I was elected to replace him and the clinic was moved to Jackson Memorial Hospital and, eventually, to the Mailman Center for Child Development, where it meets regularly every Tuesday from 9:00 to 11:30 to evaluate, on the average, seven cases a week. Since 1968 Evelyn Shields has been our super-secretary. Many fine specialists have served on this team over the past 10 years, as seen in this photograph taken in 1978:
My early dream

As a camp counselor and later as director of my own athletic day camp, I realized the value of early training of special sports skills to young boys. By 1945, when I became interested in cleft surgery, it was my plan to create a special camp for cleft children where they could enjoy the learning of certain skills, gain the confidence such mastery brings and thus offset their apparent handicap. This camp was to have a dentist and speech pathologist, besides a cowboy, and athletes as counselors. Although I have not entirely given up the camp dream, I find that all my time and energy are being sapped in the concentrated effort to bring cleft infants to attractively functioning and appearing adults, which leaves little time or energy to teach a kid, except my own, the Texas skip, an arm roll or a right cross. I do request the cleft patients' parents to encourage, instruct or seek instruction in special skills for their children, and under no circumstances to withhold them from any sport to which they are attracted!

In 1976 orthodontist Howard Aduss of the University of Illinois Medical Center synopsized the value of the team:

We are now seeing young adults who are the product of what has come to be known as "the team approach" to the treatment of clefts. On balance, this system has resulted in better treatment, fewer complications, and less deformity. At the same time, and most importantly, the clinician functioning within the environment of the team has not lost his individuality or freedom to innovate, but has developed new techniques based on input from this interface with other team members.
AN ANALYSIS OF THE TEAM

Herbert Koepp-Baker of Southern Illinois University, Carbondale, who incidentally has been a falconer for 30 years training and flying peregrine falcons, gyrfalcons, goshawks, eagles and American redtails in many parts of the world, also has had an interest in cleft palate. At the age of 10 years, on a farm in remote northern Michigan, he heard a cleft palate person speak, and after his mother explained, "Lawrence's mouth does not have a roof," he became intrigued. Years later in Pennsylvania he worked with Cloyd Harkins, experimenting in constructing and fitting prosthetic speech aids for young and old cleft palate patients. In 1978 he recalled from North Carolina:

Harkins and I taught the first formal course in prosthetic rehabilitation of cleft palate patients for a group of 25 dentists, surgeons, speech pathologists, nurses and social workers, and at the final meeting of the course the class determined to organize, becoming the Academy of Cleft Palate Prosthesis—later to become the American Cleft Palate Association. This is probably the earliest interdisciplinary effort in the field of orofacial disorders.

In 1971, in Cleft Lip and Palate, Koepp-Baker wrote on the cleft palate team. Here are highlights:

An impressive feature of congenital craniofacial deformities is the multiplexity of functional impairment which they induce. The primary goal in the treatment of children with these disorders is the reduction of the disabilities which attend them, and the alleviation of the personal and social handicap they impose. . . . The clinical team is a logical response to this need. . . . [It] makes possible a diagnosis derived from broader and more accurate sources of information, and more representative judgments and decisions. . . . [The roster of specialists] may involve: audiology, clinical psychology, plastic and reconstructive surgery, medical-social work, orthodontics (dento-facial orthopedics), otology, pediatrics, pedodontics (general dentistry for children), prosthodontics, and speech pathology. . . . There is little room for exclusive authoritarianism in clinical leadership. . . . Ennui can be the team's most insidious disease. But it can be prevented by the early and continuing recognition that a cleft palate team can be and must be more than the conventional "medical conference." . . . There are actually two measures which recommend themselves: research and continuing education. . . . Orderly, disciplined scientific investigation, if properly employed, can transfuse the team organism. New and stimulating ideas and
fresh, challenging information and point of view are critically essential. Properly controlled research recharges the team's flagging batteries. . . . There is also the urgent need for enlarged bases of communication in the team through continuing education. . . . I am constrained to make an important concluding point. . . . I have come to regard the word *multidisciplinary* as reflecting the quality of immaturity. The proper term describing the mature and effective team, as I conceive it, is *interdisciplinary*. It better suggests the attribute of interpersonal and interprofessional interaction that distinguishes this form of human enterprise.

Of course, when it is all added up, it is the surgeon in the operating room who wins or loses the game in each case. The choice of his surgery and its timing must be influenced by the facts about results seen in the orthodontist's models and the speech results as analyzed and aided by the speech pathologist and the radiologist.

**SPEECH THERAPY**

A most important aspect of postoperative palate habilitation is speech therapy. As early as 1889, Billroth had a remarkably clear understanding of cleft palate speech. As translated by Clodius, he wrote:

Dr. R. Coën lets the patients read. He reports upon the status of speech, as regards which sounds were pronounced normal and which defective, before he starts instructions. Speech therapy consisted of making the patients read loudly and especially to accent the vowels, thus training the muscles. The sounds formed in the anterior oral cavity were pronounced more easily than the ones originating from the posterior oral cavity. The voiceless sounds were more difficult to pronounce than the voiced; the plosives were less distinct than the hissing sounds. /L/ is uttered most easily, /G/ with most difficulty.

Professor Exner mentions the physiological interest of these cases, because the adults, like children, must learn to speak. As opposed to the children, however, their disadvantage consists of the fact that the adults have to forget their previous language and innervation feelings and acquire new ones.

There are several books and numerous book sections devoted specifically to the subject of speech therapy. It has been my good fortune to know three "prima ballerinas" of the speech specialty:
Muriel Morley of Newcastle, Madame Borel-Maisonny of Paris, and Betty Jane McWilliams of Pittsburgh.

Morley

Muriel Morley, speech pathologist for Wardill and later Braithwaite in Newcastle upon Tyne, England, has written a classic little book, *Cleft Palate and Speech*, now in its seventh edition. Here are some of her reminiscences in 1976:

It is the nature and the prerogative of the elderly to look back over the years and perhaps to see events in a perspective which is impossible to the young and to those actively involved in creating new events.

In the middle of the 1920s, a young surgeon, William E. M. Wardill, in Newcastle upon Tyne, became interested in and concerned about the social problems facing those with abnormal, and frequently unintelligible, speech due to a cleft palate, both before and after surgery. Wardill was one of the first surgeons to give time to the follow-up of his patients and to a careful study of the speech results he was obtaining. It was at this time that we first met, and I was invited to help with the speech therapy of his patients. For the next fifteen years or so, during the 1930s and 1940s, various operative procedures were devised, aimed to produce raised scar tissue on the posterior pharyngeal wall, to narrow the pharynx and to lengthen the velum, to improve the mobility of the velum and to reduce the formation of scar tissue of the palate. Many surgeons were now operating upon children in infancy, as it was thought that if successful surgery were carried out before the child began to speak, faulty patterns of articulation would not develop. As many general surgeons continued to operate on this condition, some of the failure to the subsequent development of normal speech could be attributed to the formation of scar tissue, causing contraction and immobility of the palate and deformities of palatal growth. This led to a theory, put forward at the end of the 1940s, that early surgery could damage the growing points of the palate, and that surgery should be postponed until growth had continued to 7 or 8 years of age. The argument amongst surgeons concerning the optimum age for surgical treatment lasted well into the 1960s. However, many plastic surgeons were obtaining good results by operating in infancy and continued to do so. One of these was Fenton Braithwaite, who succeeded William Wardill in Newcastle upon Tyne.

Braithwaite, when operating on a lip, felt the essential aim was to unite the tissues as nature intended them to be and to leave growth, stimulated by muscle activity, to complete the process. He applied the same principles to the surgical repair of the palate. Braithwaite rarely used a pharyngoplasty and never as a primary procedure, as he aimed to avoid damage to the
mobility of the posterior pharyngeal wall. He used lateral incisions of the palate within the alveolar margins, which were carried posteriorly around the lateral walls of the pharynx and partially behind the posterior pharyngeal wall. This allowed the lateral walls of the pharynx and the elements of the palate to approach the midline, so that the soft palate could be sutured without any tension, thus again producing a muscle transplant of the lateral pharyngeal muscles. The optimum time for this operation was considered to be around the end of the first year of life.

Within a few days of birth, the normal reflex co-ordinations for sucking and swallowing become established. However, children begin to develop the co-ordinations for speech through vocalising and babbling, and certainly from the sixth month, these tend to become increasingly established and are necessarily abnormal in the child with a cleft palate. These faulty co-ordinations, in the control of the oral and nasopharyngeal outlets with lip and tongue movements, also tend to improve postoperatively, but if operation is postponed until speech is fully established in both its sensory and motor aspects it becomes increasingly unlikely that these patterns of articulation will change spontaneously. However, the majority of those operated upon at the optimum time (before 3 years) were observed to develop normal speech rapidly, or more gradually, without any specialised help. Continuing observation every six months showed that 97% of the children had adequate physiological control of the nasopharyngeal airway postoperatively, the majority of whom developed normal speech which persisted into later life.

Certain problems arose, however, during growth. It was necessary to watch for any hearing problems which might be sufficient to hinder speech development. There were also children in whom the interference with the normal development of the palate had occurred so early in its growth in pregnancy that there was only minimal development of palatal tissues, too limited for any operative procedure to be entirely successful at the first attempt. Some children need help in acquiring the requisite co-ordinations and control of the nasopharyngeal airway and articulation, and especially if associated with mental retardation and also when operation had been postponed until fluent speech had become fully established. There were also certain children with no palatal abnormality who have difficulty in establishing the normal phonology for intelligible and normal speech. Some such children will also be found amongst any group of children with clefts of the palate. Such children will have greater difficulty postoperatively acquiring the normal muscle movements and co-ordinations of the lips, tongue, palate and pharynx, and in developing normal articulation when the anatomical and physiological conditions are adequate.

These are my personal experiences, particularly in working from 1932 until 1963 with two eminent plastic surgeons in Newcastle upon Tyne. It
has been an interesting experience to observe the development of the treatment for this condition over a period of forty years and its gradual improvement until surgery can now achieve a functional result in most of these children.

**McWilliams**

Dynamic and articulate Betty Jane McWilliams, speech pathologist and director, Cleft Palate Center, University of Pittsburgh, in 1976 wrote some pertinent general observations:

1. Speech therapy is not for everyone and everyone is not for speech therapy.
2. Speech therapy is no substitute for an inadequate velopharyngeal valving mechanism.
3. It is a national disgrace that so many children with inadequate velopharyngeal valving mechanisms are being subjected to years of speech therapy that has no chance of succeeding. Steps must be taken to assure that all children with this problem get the kind of diagnostic and treatment services which they require.
4. A geographical accident appears to be responsible for determining whether children are going to have adequate management for cleft lip and palate or whether they are going to be made worse by inadequate treatment procedures.
5. The plastic surgeon is the key man on the cleft palate team because he is the only one who can restore structures to what they ought to be.
6. The speech clinician can rarely claim the credit for a cleft child who speaks normally. We are primarily diagnosticians and assessors of outcome and must rely, for the most part, upon others to provide mechanisms that will support normal speech.
7. Feeding need not be a severe problem for children with clefts, but it often is because professionals are inadequately equipped to provide instruction to parents.
8. Breast feeding need not be impossible for the child with palatal defects. It is difficult but it can be done. More attention needs to be focused on this interesting area.

Then in 1977 she discussed speech problems associated with cleft palate:

It has taken generations of surgeons and speech pathologists working together (not always in the warm harmony implied in the discussions of "team interaction" written by Pollyanna and her successors) to realize that there is no such thing as a "typical" speech pattern associated with cleft
The literature has, in fact, often rendered a disservice to children with clefts and the professionals who treat them by failing to come to terms with the beautiful reality of essentially normal speech in at least 75 percent of cleft children who are adequately treated from birth (Morris). The tragedy of this failure to state that excellent speech is the "expected" outcome, primarily from surgery alone, is that those with a success rate of zero are really not being challenged to take an honest look at their grim results. Thus, unnecessary human disasters continue to occur. We all share some of the responsibility for this—even though these events, of course, occur only in a vague place which we know as "Elsewhere, U.S.A."! Why don't we simply admit that we are seeking normal speech, that we are very often successfully achieving it, and that all children with clefts are really entitled to this "equal opportunity"?

Responsibility for these remarkable advances in "cleft craft" belongs primarily to the surgeon. An information base on velopharyngeal closure has been contributed by speech pathologists, and speech pathologists have forced surgeons to new objectivity in assessing their results. However, the beautiful speech demonstrated by many children with palatal clefts is almost never the result of speech therapy per se. On the other hand, the surgeon can no longer blame his poor results on poor speech therapy and expect the speech pathologist to accept the verdict and the subsequent guilt without bringing into question the adequacy of the velopharyngeal valving mechanism and the possible role of other factors which may contribute to speech problems and to which cleft children seem to be particularly prone.

Among those factors, we consider very early in infancy the potential role of the almost universal otitis media found in children with cleft palate. Early treatment and adequate control of this condition appear to have a positive effect upon expressive language development which many studies have shown to be somewhat slow in pre-school children with clefts (McWilliams; Shames and Rubin; Smith). A part of the expressive language deficit, however, seems to be related to willingness to talk rather than to an actual disability. This has been shown with little children whose habitual sentence length was short and who usually showed less complexity than would be desirable but who could, when they were sufficiently comfortable, use the longer and more complex sentences appropriate to their life ages. Thus, while language disorders may occur in cleft children, the danger of wrong diagnosis is apparent. Nursery schools often have much to offer the average cleft child whose middle ear disease is well controlled but who needs to be stimulated to talk as well as he is able.

Another speech problem which cleft children often have is a delay in consonant articulation development. These delays are not necessarily directly related to the original deformity, but our own simplistic approaches to
problem-solving often lead us to treat the wrong thing. A seven-year-old boy is a case in point. He had no hypernasality, nasal escape, nasal turbulence, or other oral-nasal resonance imbalance. His articulation pattern, however, was immature with the substitution of w/r, 1; f/θ; and d/ʊ. He reported that he was in "speech class" and that he was doing "blowing exercises" because he had "a cleft palate" and had to "strengthen the muscles" of his "tongue." His articulation disorder went untreated because the clinician erroneously assumed that his speech problems must surely spring from poor velopharyngeal valving and that blowing was the best way to help him improve. The clinician thus failed to relate to the aspect of his verbal output that required modification. Little harm was probably done, but it was an expensive error in terms of money, time, and emotional investment. And the poor clinician was destined to failure, a failure sometimes unfortunately obscured by the passage of time, one of the primary modifiers of all kinds of early childhood behavior. We often look like experts because we fail to give credit to Nature's provision for maturation.

We must be aware, too, of the ever-present maxillary problems, including missing teeth and crossbites, that influence tongue behavior and may lead a child to develop a lateral lisp. This deviant channeling of air for sibilants is confusing to many listeners because they can't distinguish between the type of error and the sound that accompanies velopharyngeal inadequacy. Both arise from deviations in the air stream for speech. When this happens, sometimes pharyngeal flaps are done. The child *still* has his problems obviously, and the surgeon may secretly feel like a failure—as does the speech pathologist who ignores structure. The orthodontist has much to offer such patients.

Another problem of a similar nature is the anterior oronasal fistula, which, most of the time, is asymptomatic. Once in a while, it will occur in the rugae, and the patient will use the channel to produce sibilants. When he does, he will usually have massive nasal escape even though his velopharyngeal valving mechanism is just what the surgeon ordered. Closing the fistula with dental wax (or chewing gum) will often reveal that sibilants can't be produced at all without that fistula. What sounded like a posterior problem can now be understood as an anterior one, and the solution is clear. I confess that we are very much aware of this kind of problem now. Once, we were close to the door of the operating room to carry out a pharyngeal flap on a seven-year-old who thought we knew what we were talking about.

There are really hundreds of things that plague the speech pathologist. Since speech pathologists, in turn, plague the surgeons—or should—these matters are also of concern to surgeons. Hoarse voice is one of these. A ten-year-old boy with a repaired cleft on the soft palate and normal speech in spite of mild inaudible nasal escape on sibilants is such a case. When he was asked to participate in a research project, he arrived with his father,
who said immediately, "I could hardly wait to come. Just listen to his speech!" In the six months since he had last been seen, he had experienced a growth spurt, and his voice had become hoarse. Nasal escape was still present, but there was no increase in hypernasality. Videofluoroscopic examinations revealed that his borderline valving mechanism almost closed but never quite accomplished the task. He was exerting every effort to maintain the speech he had once had, and he was sacrificing his vocal cords in order to do so. Laryngoscopic examination revealed large bilateral vocal cord nodules (McWilliams et al). A pharyngeal flap was constructed, and the voice quality gradually returned to normal as the nodules diminished.

Then there are the children who really do have velopharyngeal inadequacy. If honest confession is good for the soul, then I should feel great after confessing that I don’t think I have much to offer such a patient once the diagnostic work is completed. There are thousands of children and millions of dollars being invested each year in programs of speech therapy that haven’t a prayer of succeeding until velopharyngeal closure—or something very close to it—becomes an anatomic and physiological possibility. Fortunately, now, the surgeon can often accomplish this with one of several techniques, usually a properly designed and executed pharyngeal flap. Sometimes, the prosthodontist must be called upon; and everybody has to settle for an appliance that will become a lifetime project for the patient. But that’s better than communicative failure which will very probably persist no matter how much speech therapy is undertaken until that complicated and vital valve can work to separate the nose from the mouth.

I hope all of this has not sounded too pessimistic. However, I think it is important to face up to human limitations, and speech pathologists have them! We can contribute to the diagnostic process and see what needs to be accomplished if the patient’s speech is to improve. We can help to change behavior that is not the result of insurmountable structural or motor problems. I even think we can assist the surgeon in evaluating the true nature of his results—an absolutely essential activity if we are to assure all children everywhere of the best possible speech. Fortunately, most plastic surgeons mirror these concerns, and valuable working relationships emerge and are maintained as a result.

Yules

Controversial Richard B. Yules of Worcester, Massachusetts, ever since his inspiring year with Robert Chase at Stanford University, has been interested in the postoperative speech aspect of cleft palate and has perhaps carried it a bit farther. In 1970 he wrote in *Plastic and Reconstructive Surgery*:
Speech therapy is an integral part of the team management . . . but all too often the speech therapist has been the scapegoat for ego-deflated surgeons. Indication for one or the other therapy was sometimes based on who saw the patient first, rather than on a rational selection method. . . . Only recently have cinefluorography and respiratory data suggested that certain categories of patients may be totally correctable with speech therapy alone—while others require mechanical intervention.

Although some speech pathologists regard nasal emission generally as articulatory deviation [D. C. Spriestersbach; D. Sherman], it is possible to distinguish some articulation problems for therapy before hypernasality is eliminated. Conversely, therapy can be oriented toward elimination of hypernasality which, once achieved, makes articulation errors easier to correct. Although some comprehensive contemporary publications deny "that motor exercises are of value for increasing velopharyngeal competence," other speech pathologists find "therapeutic exercise and velopharyngeal gap" to be related. Surgical researchers have succeeded in training patients to constrict their circumpharyngeal sphincter voluntarily, getting them to condition this new-found pharyngeal aid into the speech sphere—thereby eliminating hypernasality in 60 percent of cases [R. B. Yules, J. E. Josephson, and R. A. Chase].

Such exciting speech results lead one to speculate on what effect postoperative motor training might have on postoperative results. More importantly, they add impetus to the attempts to define those variables which allow selection of those hypernasal patients who do not need surgery but who can benefit from speech therapy.

Laub

To emphasize the importance of speech therapy, Donald Laub of Stanford University wrote in 1976:

I have trained 2 people, one from Mexicali, Mexico, and one from San Pedro Sula, Honduras—both only Spanish-speaking schoolteachers—at Stanford—via totally bilingual interpreters who made tapes of the texts and the lectures and returned them to their country to follow and teach our postoperative palate patients. This has led me to the conclusion that speech therapy should be carried out on almost all patients, not just ones with "insufficient anatomy." Speech therapy, I am convinced, should have a greater role in palate habilitation and this is my present "kick" in cleft palate.
Richard Jobe of Stanford was presented with an 11-year-old boy who had had his secondary palate cleft closed by his general practitioner at the same time he did a tonsillectomy. As the child had wide open rhinolalia, Jobe used a superiorly based pharyngeal flap. He recalled:

The patient had an uneventful postoperative course, though since there was a slight difference in opinion in his family as to whether or not the surgery should be done, he acted out every minor agony of the surgery to the great detriment of his mother, who was in favor of the surgery, and for the pleasure of his father, who was not. The family was immediately annoyed, of course, postoperatively because the child did not have a miraculous recovery of speech to normal. I lost contact with the patient.

About two years later at a cleft palate clinic in San Jose, a speech teacher brought in the same youngster. She reported having met this child in the school speech therapy situation and had introduced him by means of tape recorder to the fact that his speech sounded abnormal. Apparently for the first time, he understood how his speech sounded to the outside world and he began, with her help, to work on making it sound right on the tape recorder. Within a couple of weeks he was able to eliminate completely the hypernasality from his speech and significantly improve his communication. Within a month of this time, the youngster would not replicate his rhinolalia for the benefit of anyone because he had learned by now to speak normally.

I cannot say with certainty that my surgery was at all necessary or beneficial to this child. Had he understood his own speech defect, he might very well have made the same conversion without the surgery. One of the most difficult chores we have is to train people who have learned to speak abnormally to understand that what sounds normal to them inside their head would sound abnormal even to them outside their head. For this reason, I insist the speech therapists use tape recorders to help in this aspect of communication.

**The Impact of Learning**

In 1977 Hughlett Morris, speech pathologist at the University of Iowa, former president of the American Cleft Palate Association and editor of the *Cleft Palate Journal*, noted:
Quite probably the most important contribution to the cleft palate story to be made by the speech pathologist is the crucial message that speech production patterns are influenced highly by learning factors.

In our great interest and concern to address the matter of restoring to normal—or near normal—the oral structures, we all sometimes forget that the patient learns to talk, and that how he learns to use the oral structures is at least as important (if not more so!) as the structures themselves.

An interesting example of this is the use of the so-called glottal stop, heard frequently in the speech of cleft palate patients and most clearly demonstrated in what most of us recognize as the Cockney dialect. Essentially, the glottal stop is a stop plosive consonant for which the stop phase (and build-up of air pressure) is at the level of the vocal folds, as opposed to the tongue and the alveolar ridge (the t), or between the lips (the p), and so forth.

We can't really know why a cleft palate speaker uses the glottal stop. However, we speculate that apparently he adopts that consonant as a substitution for the other stop plosives because, to his ear, the glottal stop sounds more like a normal k (or t, or p) than does a k with accompanying nasal escape of air pressure. And so in early childhood before surgery (or dental prosthesis) has been successful in providing velopharyngeal competence, many cleft palate children use the glottal stop in their speech as a substitution for other stop plosives (most likely, the k and g).

And, because that substitution has been learned, just as are other aspects of his speech and language, he may very well continue to use the glottal stop, even after velopharyngeal competence is obtained by physical management and there is no longer any "need" to do so!

Taken alone, then, the presence of glottal stops in a patient's speech is not a useful observation for diagnosis of velopharyngeal competence, because we don't know whether the glottal stops reflect a present physiologic deficit or the patient had such a deficit in the past and is still behaving as if he still has it!

When we begin treatment for such a patient, we first must determine whether the velopharyngeal mechanism is competent. If it is not, referral for consideration of further surgery is needed; if it is, speech therapy is indicated.

Jack F. Bensen joined the Speech Department of the University of Miami in 1955, the same time I came to Miami, and we have worked together ever since. He is an excellent clinical speech therapist and here are some of his thoughts:

Speech is a learned process, learned by imitation starting shortly after birth. The child imitates the sounds he hears and the usual end result is a speech
patterning similar to that used by his parents and his peers, but unique to him.

The speech pattern of the individual with a cleft palate is the result of his attempting to produce the language patterns of his environment with an inadequate mechanism. Attempts to imitate the sound patterning around him, but with less success, result in the development of compensatory adjustments, or when these are inadequate, either acceptance of distorted sound patterning or some withdrawal from speaking or any combination of the three.

Once the cleft palate child finds some method of reproducing a sound which resembles the sound being imitated, he will continue to utilize this manner of production of that particular sound and begin the establishment of a habit pattern. When compensatory adjustments become habitual, they resist change and the longer they are utilized, the more ingrained they become, increasing the difficulty of eradication.

Speech therapy requires utmost cooperation, dependent upon the intellectual maturity, attitude and motivational drive of the child and the skill of the therapist. There are four areas of concern for the speech therapist.

1. **Palatal Functioning**

   If the individual has nasal emission of air during the production of all plosive and fricative sounds we have a problem. Assuming that there is adequate length and the potential for closure, it is necessary to somehow activate the function. I have found two methods effective for doing this; the more desirable is direct muscle training using a mirror. This is a very simple procedure—simply have the patient imitate your palatal action while saying "ah," reward as motion increases. When it appears that closure is obtained consistently have the patient prolong "ah" and then say "p." If "ahp" comes out without nasal emission you are on your way. "p" is the consonant of choice because there is no tongue movement which might interfere. From "ahp" go to "ahpah" and then to the other plosive sounds. Closure for the fricatives is best obtained by starting with a plosive and transferring to the fricative, i.e., "pf" "bv" "ts" "dz" etc. The secret here is to have the patient allow a minimum amount of air to escape on the fricative element of these sounds at first, maintaining as much intra-oral pressure as possible, and gradually increase the air flow.

   If the above method fails, try direct stimulation. This is done by using your finger or a tongue blade and exciting the palatal muscles by stimulation. As motion increases, have the patient feel and observe what is happening and carry on as with the mirror training.

   Blowing exercises are better for young whales and dolphins.
2. **Production of Consonants**

Always begin working on the specific sound which is easiest for you to get the patient to produce. If you have a choice of two or more, start with the one that most distorts the speech. If you can get adequate production of a distorted, substituted or omitted sound by imitation, you are in clover and can go on from there. The next lucky way is to give simple directions such as “Shut your teeth and blow” for “s” or “Put your tongue behind your upper teeth and blow but don’t let the air out” to get the implosion for “t,” then have him drop the tongue suddenly over and over again, increasing the speed. When you have a child who consistently uses a glottal catch for the plosives, start with “p,” then “b,” then “t,” then “d,” and finally, “k” and “g,” unless he can easily get one of the sounds out of this order. The “k” and “g” are the most insidious and sometimes seem to take forever. Don’t despair. With a considerable amount of ear training and manipulation it will eventually come.

3. **Facial Grimaces**

The amount and speed of movement of the muscles used for nares constriction by individuals with cleft palates is truly remarkable. In their attempts to produce some semblance of normal sounding consonants, they develop an amazing ability to shut off the nasal passageway, unfortunately at the cost of facial contortions. It is wise to attack this problem as you are working on specific sound production. Don’t make the mistake of trying to eliminate these grimaces all at once. Take one step at a time and use the mirror constantly, offering more encouragement the younger the person.

4. **Voice Quality**

This is the most difficult aspect to treat, as it is the most persistent of all the anomalies of cleft palate speech. Excessive nasal resonance is universal in the cleft palate population and, even after successful surgery, continues in almost all cases. Why? In the first place, we build up an aural image of self and resist any change; secondly, we have built up, through perceptive cues and kinesthetic awareness, a habitual muscle patterning subconsciously, which becomes automatic. Any change must start with an awareness of need and desire for change, and right here is where the trouble begins, because change in voice quality will make the patient sound different. Besides resisting this change, most young children lack the ability to make the finite adjustments of the mechanism required. Fortunately, this can be handled somewhat obliquely. With young children, don’t attempt to work on voice quality directly. Be a bit more subtle. During drill on the faulty consonants have him open up wide but relaxed to incorporate a vowel sound. At the same time adjust the volume. When all the rest of your therapy is accomplished and this excessive nasal resonance persists, you can begin to attack.
the problem head on. Now this really becomes an art. Through imitation, suggestion (open up a bit more, make your lips round, feel the sound by your teeth, hit your hand with the sound), you must shape and manipulate and, when you get a sound that is "good," pounce on it and have him repeat and repeat, feeling and hearing what he is producing. Remember, what you are doing is training him to listen and feel perception and sensation, and this takes time.

Speech is habit and every day that an individual practices speaking with an inadequately functioning palate, he increases the development of compensatory adjustments and makes them more difficult to eradicate, justifying the speech pathologist's plea:

Surgeon,
Surgeon,
Give him a palate true
One that functions
As it's supposed to do.

We don't want a very short one,
An immovable, tight or cleft one,
But one set back
In its right track
And we'd like it before he's two.

At the 1978 Florida Cleft Palate Association meeting, Miami speech pathologists Jan Riley and Garnet Sinko made some practical observations:

Foibles and follies of speech therapy can be attributed to three basic sources:

1. A poorly qualified speech pathologist. Minimal requirements for a speech pathologist include an earned master's degree with a major in speech pathology, and attainment of a Certificate of Clinical Competence awarded by the American Speech and Hearing Association.

2. Timing of referral is important in two respects: (a) If the child is referred in the first 12-18 months of life, over the years a qualified speech pathologist can inform the parents of the normal process of language development, refer for necessary surgical and dental services, and prevent establishment of poor speech habits by assisting with suggestions for speech and language stimulation. (b) Speech therapy at any time is limited by the amount of velopharyngeal incompetence; in the presence of complete lack of V-P closure, it is sheer folly to expect nasal emission and hypernasality to disappear or to expect the acoustic end product of articulation and resonance to be adequate. However, glottal stops and pharyngeal fricatives can be eliminated and correct tongue placement for consonants developed, thus reducing the amount of time subsequently required in therapy following surgery. It is folly to tell the child with velopharyngeal incompetence "try
harder” or “listen,” because the more physical effort the child expends, the more nasal emission will be produced. Without adequate closure the child cannot make p, b, t, d, k, q, s, z, sh, ch, or j sounds correctly, unless his nose is pinched closed. Listening for accurate production will only frustrate him and contribute to a poor self-image. It is further folly to expect a child with marginal closure, just because he can produce sounds correctly in isolated words or short phrases, to talk normally in conversational speech. In fact, this inability should be cause for referral to evaluate the need for additional surgery. The final folly is to believe that if a child has achieved velopharyngeal competence as a result of surgery, all deviant, habituated learning will have been immediately eradicated. The therapeutic process can sometimes be lengthy and is always dependent on the third source of foibles.

3. These are the environment in which the child resides and the problems of mental retardation, psychological disturbance and hearing loss, all of which compound and frequently transcend the problems associated with speaking with a cleft palate.

The most imaginative cleft lip and palate habilitation program including speech therapy has been instituted by Edward H. Kopf in Las Vegas, Nevada. To see his therapy clinic in action, which I did in 1972, is both touching and thrilling, but as it is his conception, he should tell you about it:

The Office Dummy

Ventriloquism is fun for everyone. We have used the technique with cleft palate children for seven years now as an adjunct to traditional speech therapy. Our office has been converted to the “fun office” for these children
who require repeated surgical procedures rather than a place of terror. The
doctor's smock and the nurses' uniforms have become symbols of love and
pleasure rather than fear and pain.

It has been our feeling that if a ventriloquist can communicate through a
puppet with its extremely limited mouth action, no facial expression and no
hands to move that person unconsciously has developed fabulous commu­
ication techniques which he can transfer to himself.

Children who have had cleft palate surgery, with or without speech
problems, as well as other children with communication problems are
referred to the free ventriloquism clinic in our office open for two hours
every Saturday morning. Children can come if they or the family feel the
need, stop when they are satisfied and return as needed when rejection or
other problems occur in their lives, for love, acceptance, and learning new
routines with their puppets.

The children range in age from 18 months to 15 years. They are taught
ventriloquism techniques, breath control, the regular alphabet and ventril­
oquism substitutes, facial expressions, delivery, jokes and simple routines
which are appropriate for birthday and all major holiday parties. We try to
give them a skill that other children do not have so that they are the first to
be invited to parties rather than the last.

The parents, especially mothers, are involved in making and repairing the
puppets, writing skits, hunting jokes, home rehearsal and weekly transpor­
tation. The fathers, other siblings and grandparents make enthusiastic
audiences at more formal holiday presentations. On major holidays, profes­
sional ventriloquists from the Las Vegas Strip come, listen, applaud, en­
courage, advise and perform one of their routines as a reward.
The children in our program learn to communicate in an exciting fun situation. They learn the alphabet early as a "head start" giving them confidence when they enter the strange world of school. They develop poise and confidence while speaking and performing before their peers, adults and strangers. They no longer fear a large crowd. They develop a sense of humor. Laughter is accepted as an expression of love rather than criticism.

When he stands up to perform with his puppet he has a dependable friend with him and he does not feel alone. The dependable friend stays with him for life. It is his puppet who has all the problems. In the beginning, it is the puppet who cannot speak well until speech becomes more polished. The excuses for the puppet's failures are marvelous. The puppet is an animal and animals don't speak well; or he is old and has no teeth; or it is a baby.
When a new "cleft palate baby" is born, the parents are invited to the ventriloquism clinic so that they can see for themselves that these children are beautiful, lovable, have normal intelligence, are clever and have pleasant personalities. They see children in all ages and all stages of repair and development. They know they have been told the truth and there are no surprises. They talk to other parents freely and can intelligently discard ridiculous folklore and old wives' tales.

Plastic surgeons do not need to learn ventriloquism to add the dimension to their offices, since there are many talented professionals and amateurs whose puppets are gathering dust in some drawer just waiting for a chance to help make a better world.

With this technique we see the development of confidence in the child, pride in the parents and love in our staff.
The three volumes of Cleft Craft have been involved with the basic science, surgical principles and detailed craftsmanship developed through centuries of experience and devoted to the transformation of a patient with a cleft into the ideal normal. After all this, what about each psyche and soul?

**Individual Reaction to Deformity**

How we are going to react to a deformity, or even to life itself, may already be determined in our genes, despite the influence of specific environmental factors. As Straith and I wrote in 1951:

Let us compare two children born in different families but both with harelip and cleft palate and both approximately 18 months of age. The mother of one brought her tiny daughter in for surgical treatment at the age of 2 years. She reported that several times she had found the little girl in front of the mirror with her fingers pushing the edges of her ununited lip together in an attempt to make them stick. This child was not only aware of her deformity but she was trying to do something constructive about it. It could be predicted that as soon as adequate surgery had been completed, this child would continue to make her adjustments quite normally.

The other child was a little boy who was kept hidden in the back of the house. Upon the approach of a stranger, he would grab the bedclothes and hold them up over the cleft in his face. One glance into the frightened, pathetic eyes peeking over the bedclothes revealed that this neglected little fellow was failing in his adaptation, and mere surgical closure might not completely heal the psychic trauma already inflicted. Thus, the best chance to avoid undesirable personality changes would seem to be complete surgical correction of the deformity at the earliest date feasible.
It has been pointed out by E. Meyer that the social and intrafamilial aspects of disfigurement, the cultural milieu (aborrence of deformity) and reactions from family and peers ("scapegoating") are at least as productive of a sense of deformity and deviancy as the individual's own reaction to his defect.

In 1978, Lynn C. Reichman of the University of Iowa noted:

Teachers rate the intellectual ability of cleft children with more noticeable facial disfigurement less accurately than cleft children with relatively normal facial appearance. Within the group of cleft children with more noticeable facial disfigurement, teachers underestimated the ability of brighter children and overestimated the ability of less bright children.

It is interesting how similar deformities can invoke such varied reaction patterns. Beethoven's pockmarked countenance probably was greatly responsible for his seeking refuge in solitude to compose a minuet rather than spending his energy at a social, dancing someone else's minuet. In contrast, George Bernard Shaw, who also allegedly had scars from smallpox, merely produced a huge growth of beard to cover them and scoffed at the world. Louis XIV decreed a new fashion in footwear to make his ungainly feet less obvious. Jimmy Durante, with the front brim of his hat turned up, seated at the piano, banging out "My Nose's Birthday," turned his head from side to side to present his huge nose in profile. Yet Cyrano de Bergerac points unhappily at his:

Tell me what hope of glory, what hope of any kind, this protuberance of mine could ever leave me.

William Shakespeare revealed an acute sensitivity to the burden of a cleft when he wrote:

So shall all the couples three
Ever true in loving be;
And the blots of Nature's hand
Shall not in their issue stand;
Never mole, harelip, nor scar,
Nor mark prodigious, such as are
Despised in Nativity.
CRIME

It has been a standing assumption that physical defects can be a strong contributing factor in antisocial behavior. As I wrote with Straith in 1951:

Any deformity that a child has not noticed himself or has not been called to his attention by siblings will certainly be brought to light in school. Children are quick to observe the unusual, and with no attempt to conceal curiosity or to refrain from ridicule, they will be frank in their discussions and opinions. They tend to shun a deformed playmate, or they "dub" him with a nickname which reflects his defect. The deformed child has the mental and physical faculty for self-expression possessed by other children, but because of his deformity, he is either restrained by others or avoids the personal contacts necessary for such expression. The handicapped child, feeling inferior and alone, craves popularity. Many times these children resort to petty pilfering in order to obtain money to attract friends. One boy with facial burns, nicknamed "scarface," stole money to buy candy to give to his playmates so they would no longer be afraid to hold his hand in games.

Childhood fairy stories pose the handsome prince and the beautiful princess against the ugly witch; comic books repeat this theme with Detective Tracy against such funny-looking characters as Flat-top and B-B Eyes; movies portray western white-hat heroes against black-mustached villains. Thus, through the early years of development, there is not only the constant identification of beauty with goodness and of ugliness with evil, but there is also the attempt to identify self with the good and the beautiful. But there comes a time in the life of every deformed child, when he realizes that he cannot take the part of his ideal hero. He is reminded of this over and over by thoughtless remarks from friends and second glances from strangers. It is easy to see how a handicapped child might become delinquent and, if merely punished, driven into crime. Rear Admiral E. R. G. R. Evans of the British Navy tells the story of a boy who was taunted and ridiculed because of his ugly, protruding teeth; he was given the nickname, "Barracuda." Gradually, he turned against not only those who ridiculed him but against all society and gathered together under his command the Scarlet Fleet. He became the most feared and ruthless buccaneer on the Seas and many of those who had laughed at him as a child at school walked the plank to their death. "Thus do the cruelties of youth make rogues."

The literature is replete with characters whose antisocial behavior is determined in large part by some physical defect. Lewin
noted two examples. Victor Hugo’s Quasimodo, the hunchback of Notre Dame, is acutely aware of his own ugliness and seems to be propelled by his hatred of himself and repugnance of his own image into the protection of beauty. Shakespeare’s Richard III is a villainous character whose awareness of his physical defects presents an insurmountable obstacle to normal social intercourse as it becomes the motivating factor in his life.

In his book *This Gun for Hire*, Graham Greene’s protagonist, Raven, is a postoperative cleft lip who justifies his life of crime as a retaliation against society for its cruelties to him:

Murder didn’t mean much to Raven. It was just a new job. . . . The cold wind cut his face in the wide Continental Street. It was a good excuse for turning the collar of his coat well up above his mouth. A harelip was a serious handicap in his profession. It had been badly sewn in infancy, so that now the upper lip was twisted and scarred. When you carried about you so easy an identification, you couldn’t help becoming ruthless in your methods. It had always, from the start, been necessary for Raven to eliminate the evidence.

Plastic surgery has been used in an attempt to rehabilitate adult penitentiary inmates. The results have been equivocal. In 1966 Spira, Chizen, Gerow and Hardy indicated that 17 percent of the inmates released from a Texas prison after receiving plastic surgery were returned during a five-year follow-up period, whereas the recidivism rate among that general prison population was 31.6 percent. In 1967 Velasco, Woollf and Broadbent reported 21.3 percent and 30 percent recidivism rates in inmates receiving and not receiving plastic surgery, respectively. Yet, also in 1967, Schuring and Dodge reported no significant difference between inmates receiving plastic surgery and non-operated controls (48 percent recidivism rate for both). As early as 1948, J. F. Pick noted:

Where criminality has become an established habit . . . resistant to rehabilitation, improvement in appearance of an adult incorrigible may change the standard of his criminal practices, upon release, from that of a common thief to that of a specialist of a higher order. It is, therefore, felt that where bodily defects or gross features exist in the youthful delinquent . . . such defects should be corrected and their trigger value removed before the boy delinquent becomes the man criminal.
It was thought that plastic surgery might be more effective in the rehabilitation of deformed delinquent adolescents. Knorr, Hoopes and Edgerton in 1968 reported:

Physical changes via cosmetic surgery are more easily integrated into the body image percept by the adolescent.

In 1973 Meyer, Hoopes, Jabaley and Allen studied 21 deformed adolescent delinquents, 14 of whom had plastic surgery (one of these had a secondary cleft lip deformity); 7 were unoperated. They determined:

There were no remarkable behavioral differences between those patients who had surgery and those who did not. Surgical intervention, as an added factor, was felt to be no more effective in achieving positive change, than psychological or social intervention alone.

It was suggested:

Adolescents may already be relatively fixed in their body image concepts, so that surgical intervention is ineffective in accelerating progress.

Yet there are many encouraging examples in which surgical correction of major or minor cosmetic defects that were triggering a change of psychological reactions and leading the individual into chronic conflict with society suddenly enabled him to cope successfully with his life.

Michael L. Lewin wrote me in 1972:

My own attention was drawn to this problem years ago by a young man with an inadequately repaired bilateral cleft lip and palate who shot his friend for taunting him about his cleft palate speech. This late teen-ager was sentenced to Sing-Sing for murder. He was rehabilitated in three or four operations while in prison. He had a bone graft, revision of the lip and a pharyngeal flap. I have been in contact with him for over twenty years. He is a solid citizen, a good family man, a pillar of society.

It is important that these selected literary excerpts and comparative statistics do not mislead. Although fiction has occasionally coupled cleft lip and palate deformity with criminal personality, the fact remains that there are very few cleft individuals who have become involved in criminal activity.
Medical opinion and teaching suggest that severe facial deformity renders an individual liable to depression, despondency, anger, resentment, frustration, hopelessness and possibly self-destruction. As recent statistics show, suicide is twelfth in frequency among the causes of death in the United States. Among older teenagers and young adults it ranks fourth. Numerous cleft lip and palate patients might be expected to appear in these statistics. In 1973 Jack Berger of Chicago, after having searched the literature, found a discrepancy; he reported only two cases in which a congenital cleft lip or palate could be considered a primary cause of a suicide attempt.

1. A 38-year-old male had been born with a bilateral cleft lip and palate. The lip had been repaired on two occasions with unsatisfactory results. The palate had never been operated. He lived a secluded life as a janitor, living in a small basement apartment with his mother. When his mother became seriously ill, he became threatened that he would lose her support which caused him to attempt suicide with a shotgun placed under his chin. Having chosen this method of suicide, the patient accomplished ablation of that deformed part of his body which he must have hated all his life. The present deformity, which was by no means an improvement over his previous deformity, at least could be explained as the result of an accident, not as a defect or deficiency with which he was born. Once healing was complete, he began to establish some social contacts.

2. A 19-year-old Caucasian female was born with Pierre Robin syndrome with a posterior hard and soft palate cleft and microgenia. She had closure of the velum at 3 years and was fitted with a dental prosthesis for the residual hole in the hard palate. Her speech developed slowly and poorly. Her father went to great expense to get her orthodontic and speech therapy and showed anger at her poor progress. The child, sensing rejection, developed a defense by becoming a chatterbox and the faster she talked the less intelligible she became. Her roommates "tuned her out" and forced her isolation, but she graduated from high school and entered college. Here her attempts to belong by excessive talking were unsuccessful. She was ignored by her classmates, became depressed, failed in her grades and finally attempted suicide by slashing her wrists. She was hospitalized on a psychiatric service where she began to understand what she had been doing to cause unsatisfactory relations and, with the improvement of her speech with a new aid and therapy, she re-entered college and chose a very suitable field—social service.
It is important to note that in both of these suicide attempts the corrective surgery had been inadequate and the results unsatisfactory.

In 1976 P. Arvez, J. Uriel and B. Vilar-Sancho of Madrid, Spain, studied 50 postoperative cleft lip and palate patients between the ages of 7 and 25 years, when non-adaptation and frustration are most intensely manifested. They concluded:

It is worthy of note that the axis of schizophrenia occupies a higher place both in males and females. . . . Depression appears in second place in the case of males, while for the females it occupies third place, with paranoia in second place. Also, social introversion was conspicuous in the females but not in the males.

Good aesthetic results in the males favoured a decrease of the pathological symptoms. However, this did not occur in the females.

SUCCESS STORIES

Most postoperative cleft lip and palate patients are not antisocial and have no interest in crime or suicide. They adapt to their environment and, depending on their surgical and orthodontic results, are more or less happy with themselves.

In 1972 Edward Clifford, with Eleanor Crocker and Barbara Pope, of Duke University made psychological studies of 98 cleft lip and palate patients treated surgically by Kenneth Pickrell 22 to 27 years before; 78 percent had received no speech therapy and 65 percent no orthodontia. In general, they presented relatively high self-satisfaction scores, with 77 of the group married. These findings supported L. D. Goodstein's statement:

Informal observational impression . . . is that the typical adult with cleft palate is happily married, gainfully employed, and a generally useful, contributing member of society.

A more detailed investigation by Clifford did reveal:

Despite these relatively high overall satisfaction scores, when various items of the body-satisfaction scale were ranked according to mean satisfaction levels, the body items associated with clefts rated relatively low. For example the item with the lowest satisfaction level was teeth, closely followed by speech. Talking, nose, and lips followed in ascending order of satisfaction.
Almost none of these items appear at such relatively low levels of satisfaction in normal adolescent population.

Also in 1972, Pickrell, Clifford, Quinn and Massengill, reviewing this same group of 100 cleft patients operated on over 20 years before, found interesting scholastic achievement:

Though 15 did not go beyond the 9th grade, an additional 58 achieved a 10th to 12th grade education, and 27 went on beyond high school [8 to trade school; 2 completed 2 years of college; 1 was a C.P.A., 1 a pharmacist, 1 a registered nurse; 8 completed college; 2 completed theological seminary; 4 obtained master's degrees in graduate school].

Edward Clifford, psychologist and co-director of the facial rehabilitation center at Duke University, admitted:

I must enjoy a psychological life as I married a psychologist.

At the Educational Foundation Symposium in 1973, Clifford explained how he responded to parents of a cleft lip and palate child when they asked whether he would grow up to be normal:

Our approach is to review with them some of the research findings with regard to the cleft palate population, that is, that they compare favorably with normal populations in terms of intellectual level, that one can find a widespread array of occupations ranging from those in the professions to unskilled laborers among cleft palate persons and that in our experience the cleft palate population is no more noted for the presence of emotional disturbance than any group. We often conclude by stating that our best guess about the baby's future can be made by looking at his family. The motivations, ambitions, abilities and value structure of the family will probably have the greatest influence on the cleft palate child, or any child.

As noted in 1971 by Charles Wirrs, psychologist for the Lancaster Cleft Palate Clinic:

In spite of compelling theoretical basis for social and psychological maladjustment in children with cleft palate, the research results have been inconclusive. If the results tend in any direction, it is toward the absences rather than the existences of maladjustments.

In 1979 Kathy Kapp of the University of Illinois at the Medical Center, Chicago, investigated the relationship of the self-concept of children with cleft lip and/or palate to the self-concept of noncleft children. She reported:
Thirty-four cleft lip and/or palate children between the ages of 11 and 13 were individually matched with thirty-four noncleft school children. Each child was given the Piers-Harris Children’s Self Concept Scale. Children with clefts, regardless of sex, reported a significantly greater dissatisfaction with physical appearance. A significant interaction effect between sex and presence or absence of cleft was found on three cluster scores with cleft girls reporting greater unhappiness and dissatisfaction, less success in school, and more anxiety. . . . It was suggested that girls may be more affected by the stigma of a physical disability because of the importance of physical attractiveness in our society."

Among the cleft lip and palate individuals there are many who have achieved unusual success. Khoo Boo-Chai reported that the first such success story, during the Chin dynasty, involved a fourth-century Chinese lad, Wei Yang-Chi, who had his lip cleft closed and later became the governor general of six Chinese provinces.

Blair Rogers found three more success stories. In the tenth century a seaside town in Yorkshire, Scarborough, was founded by and named as the result of an invasion by a Scandinavian, Thorgils Skarthi (“harelipped”). The eighteenth-century Thomas Robert Malthus, despite a cleft lip and speech impediment, preached as an Anglican minister until his bishop suggested he give up the priesthood. Thus, by default, Malthus turned to economics and was later appointed professor of modern history and political economy in the East India Company’s College at Haileyburg. Twentieth-century Bruce Lowery, an American writer living in Paris, was awarded the Prix Rivarol in 1961 for writing, in French, a sensitive novel entitled La Cicatrice, which tells of the problems of a young boy affected with a cleft lip scar. Here is a review of his book in English:

This is a story of a boy with a scar, the relic of a harelip. Happy at home in his parents’ love and the devoted affection of a younger brother, he suffers his first great shock at school in the stupidity, cruelty, and spiteful fun-making that is so prevalent in the thoughtless world of children. Disconcerted by the wickedness which his small infirmity provokes, he himself ends by driving to despair the few beings who have shown him any affection. Driven by some troubled impulse, by an extremely complex urge, he harms the one boy whom he really loves and who has done most to protect him from the others. The remorse that follows this act is conveyed in the most moving fashion, while the boy discovers, without being able to put it into
words, that physical afflictions are as nothing beside scars on the soul. His experience, the fruit of suffering, is complete at last, when a strange and beautiful gift from beyond the grave reveals to him the meaning of love.

Lowery’s book was widely acclaimed in French literary circles, and the author, himself born with a complete unilateral cleft lip well closed by an American surgeon, subsequently translated his story into English, American vernacular, Spanish and German.

In 1976 Aarne Rintala of Helsinki, in *Plastic and Reconstructive Surgery*, presented the remarkable story and work of Thomas Ragawaldinhoika, the eighth child of a farmer of Tyrvää in the kingdom of Sweden–Finland, who had been born in 1774 with a unilateral cleft of the lip and palate. Although he suffered from poor health and had none of the advantages of higher education in that time, he became the most important Finnish lay psalmist of his time. Lay psalms were verses printed on loose sheets, corresponding in a way to modern newspapers. In the opening psalm of his first publication, he described himself, noting his cleft characteristics, abnormal appearance, speech difficulty and inability to suck.

In another lay psalm he described his preoperative fears and trials, the operation itself, the aftercare, and his own gratitude to Gerhardt Odenadt, surgeon of the Turku Royal Dragoon Guards regiment, and to God.
4. For when born, in my poor Lip,
From the first there was a slip,
Which prevented me to talk,
Strangely seemed my Face at fault.

5. Oftentimes for my sad Flaw,
I did try to find a Cure,
But it was not yet the day,
When God's help was given to me.

6. For this thought I with me bore,
And it was a burden sore,
That the Pain I could not stand,
It would leave me quite unmann'd.

7. It was also in my mind,
When a cure I tried to find,
That God's Will it could not be,
Since at birth 'twas given to me.

8. Till at last God gave me strength,
Broke the bones of fear at length,
So that being afraid of Pain,
Seemed no surprise again.

9. In my Conscience I found Peace,
In my Heart a sweet Release,
For the Preacher of the Word,
Strengthened me to trust my Lord.

10. To a Doctor I did go,
My Deformity to show,
And he vowed to me he would,
Do for me all that he could.

11. And I did myself prepare,
Called to Jesus in my Prayer,
That He who had suffered so,
Might help me in my Trouble now.

12. At God's Mass, upon my knee,
Did I make my humble Plea,
And indeed I was assured,
Of help coming from the Lord.

13. In the month of April sweet
On the Sixteenth day of it,
Did the Doctor me attend,
My deformity to mend.

14. Put before me then a Chair,
And I sat me gladly there;
Held my Face and with knife-tip,
Cut into my deformed Lip.

15. Soon I held my Eyes closed tight,
And my Hands with all their might,
On my Heart together pressed,
Fingers twisted in Distress.

16. Felt a sharp and dreadful Pain,
Felt the agony again,
So my Flesh shivers and shakes,
All my Body the pain takes.

17. But within with Jesu's strength
Helpen was my Mind at length,
So no sound from me was heard,
Not a cry nor yet a word.

18. Though the Blood from me did pour,
From my Veins came more and more,
I was in a sorry plight,
And I was a gory sight.

19. For my Shirt, my Clothes, my Breast,
Every part of me was messed,
With the stream of warm red Blood,
Running down me like a Flood.

20. But the good God's mercy too,
Helped me in my Plight anew,
And the hardest Pain He tempered,
His Son's suffering remembered.

21. And when my poor Gums were cut,
Where the Doctor's knife was put,
Then did I remember Jesus,
With His Wounds that came to save us.

22. And when the Scissors cut away,
Skin from flesh of lip that day,
I remembered how He bore,
Many a harsh blow so sore.

23. When the needles sharply pricked,
And my lip together stitched,
I remembered then the Spear,
That did pierce our Lord so dear.

24. Pierced the side and through the heart
Of our Saviour, Jesus Christ,
In these thoughts I did attain,
Sweet relief from all my pain.

25. Lo! See how God's mighty strength,
Gave me comfort now at length,
So that my Head did not swoon,
Nor my Heart stop beating soon.

26. When I saw before me next,
How the Blood upon my Breast
In a kind of Jelly set.
Then with dreadful fear I swear.

27. When the Doctor's work was ceased,
From his task he was released,
Then at last I oped my Eyes,
And my hands did clean and dry.

28. Wiped the sweat off my brow,
That from pain did start and flow,
And my shirt too did I change,
Cleaned the blood from every place.

29. 'Twas with weary toil that day,
From my chair I went away,
Went to lie upon my Bed,
On my Pillow laid my head.

30. Now I was a prisoner,
Bound up like a poor slave there,
Not a piece of bread to eat,
For two weeks no taste of meat.

31. The while the Doctor came to see me,
Several times that he could see,
How my poor lips they did look;
At last from me the needles took.

32. The first he took upon the Tuesday,
The second he removed on Wednesday,
The third he took on Friday then,
Ah! I could really feel the pain,
For that they had rusted fast,
To the flesh had stuck at last,
So that I was changed in feature,
Pale I was, a sorry creature.

33. Yea, it was a dreadful thing,
How the needles they did sting,
When the Doctor pulled them out;
Then I suffered without doubt.
But all thanks to God I sing,
Who created Everything;
From the pain He me relieved,
And from my Deformity;
And a good Physician gave,
Doctor Odenadt the grave,
Blessings to his potent Salves,
To his Ointments and his Balms.
Thus the mercy of the Lord,
To man's work he doth afford,
Let us honour Him most high,
Who gives help to the needy.
So my suffering and sorrow,
Were relieved for the morrow,
Jesus, of Physicians best,
To Thee be my thanks addressed.
The success of the patient’s adjustment after the surgery is impressive, as he soon married a bride 10 years younger than himself. When this marriage was broken because of her infidelity, he married again—producing a total of nine children.

Canadian John Stephenson, born with a cleft of the palate, studied medicine in Edinburgh and, after palate surgery by Roux in Paris in 1819, wrote his graduation thesis on his own operation. He then returned to Montreal, enjoying a successful career. Honorable Peter McGill gave Stephenson credit above all others for McGill College.

Other examples of postoperative cleft patients who have attained fame and fortune include renowned British surgeon Sir James Berry, innovative Newcastle anesthetist Philip Ayre, several notable American plastic surgeons and several British and American actors, including the Shakespearean actor Stacy Keach, star of television series "Caribe," who has a Blair-Mirault lip closure and was honored in 1976 with the American Cleft Palate Educational Foundation Award.

SUCCESS WITHOUT SURGERY

My favorite cleft lip story is *Precious Bane*, written by Mary Webb, recipient of the Femina Vie Heureuse Award for 1924–1925 for the best work of imagination in prose or verse descriptive of English life. The setting is the village of Sarn Mere in Shropshire, near the time of Waterloo. The heroine, Prudence Sarn, has an inner beauty in spite of her unoperated cleft lip deformity, but she is tortured by guilt, superstition, prejudice and constant comparison with the ideal of feminine beauty. Her sense of futility and suffering is expressed in these quotations:

"Could I help it if the hare crossed my path?"

"My poor hideous lip was, as it were, my sin, though a kind of innocent wickedness."

"... And I’d begin to dream of being as beautiful as a fairy..."

Her jealousy was understandable: "All in a minute her mouth was a rose, and I knew I couldn’t abide her."

A villager could be heard to say of poor Prudence: "The woman with the hare-shotten lip. A very queer creature. But it makes ’em queer, you mind, to be born the like of that. Some say she’s a bit of a witch."
Of her brother Gideon Prudence had said: "Gideon could have grown what they call a moustachio and looked very well and none need have known he'd got a hare-shotten lip."

When Gideon had said to Prudence, "Being as how things are, you'll never marry, Prue," her thoughts expressed her despair: "My heart beat soft and sad. It seemed such a terrible thing never to marry."

The cost of a cleft lip surgeon for these poor farm people was a formidable obstacle, as expressed by Prue herself: "and I knew it would take a deal of money to cure a hare-shotten lip."

Yet it had been promised: "Give her money up to fifty pound, when we've sold Sarn, to cure her lip."

The hero, Kester Woodsaves, a young weaver whom Prue admired from a distance, took a stand against the brutality of bull-baiting by dogs and, in order to stop the cruelty, offered to take the dogs on one at a time. He had no trouble as they were all his friends, except a new vicious one that went for his throat. Prue saved him with a knife she had carried for his protection, and then quietly left the scene, almost unnoticed and saying to herself, "Nay, Prue Sarn, you be nought but his angel, and a poor daggly sort of angel, too."

Then followed frantic toil and thrift to bring in a corn harvest that would give security to the Sarn family and an operation for Prudence's lip. Misfortune intervened, however: the corn crop was set on fire and all was lost. The village folk turned on Prue, and had begun to stone her to death when Kester Woodsaves rode up, cleared the crowd and, as he lifted her onto his horse, said: "Come here then, Prue Woodsaves!"

Prue cried in disbelief: "But no! Kester . . . you mun marry a girl like a lily. See, I be hare-shotten!"

But Kester would not listen. Looking down into her eyes, he said: "No more sad talk! I've chosen my bit of Paradise. 'Tis on your breast, my dear acquaintance!" And when he'd finished those words, he bent his comely head and kissed her full upon the mouth.

**EXPORTING GOODWILL**

As the defect of any cleft of the face and mouth is a handicap, it follows that effective correction of the deformity will benefit the individual in his social setting, whether his culture be sophisticated or primitive. The goodwill engendered, like a pebble dropped into a pond, will send out ripples far beyond the original tiny splash.

My first experience in this kind of diplomatic missionary work came in Korea with the First Marine Division. Many incidents of
that time have been related through these pages. At the end of hostilities, the purpose of the marines was to rehabilitate the country, and this population was totally untouched by plastic surgery. Every anomaly and deformity imaginable was roaming about, and I went to work. This was a little unorthodox because ordinarily, when the marines were not fighting, they were just as gung ho about relaxing, and this attitude pervaded the camp. In order to do cleft surgery, it was occasionally necessary to have an anesthetist. At first he was reasonably enthusiastic. As he was not quite as infatuated by clefts as I, it became necessary sometimes to assist him, almost by the scruff of his neck, to the operating room. A recent note from Bertram Bromberg probably tells it best. He wrote:

Ralph, my brother-in-law, Irv Weinberg, was an anesthetist serving in Korea during your tour of duty there many years ago. At any rate when he returned and was relating his experiences, the first thing he wanted to know from me was if I knew a screwball plastic surgeon by the name of Millard, who operated night and day on every cleft lip in Korea. I have been subsequently delighted through the years to explain to him your contributions which were in their early stage of development at that time and have pointed out that he also, in some small way, played a role.

In my editorial in the 1962 Journal of the Florida Medical Association, missionary surgery in underdeveloped countries was suggested as an important step plastic surgeons could take toward improving international relations.

In this do-it-yourself diplomacy, the plastic surgeon can be particularly effective. Ours is a specialty which, with its hint of magic, touch of drama and more than a dab of art, is mastered by so few yet respected by so many. There is also its great humanitarian appeal. What act can bring greater rejoicing in a family and a village than the transformation of an infant with a cleft in lip, expression, palate and speech to a happy, sucking baby? The infinite influence of this specialty lies in its power to render the deformed and mutilated suitable to take their place in society and serve as living monuments not only to our specialty but to our way of life.

Jamaican program

In 1959 Kenneth McNeill and I started a Jamaican plastic surgical program. This continued with only minor interruptions until the last few years. A Jamaican surgeon, Tony Jackson, has
completed a year in our plastic surgical residency program at the University of Miami, preparing to take over a unit in Jamaica. Residents from Miami make short rotation work trips to his unit and that of Sidney Williams, continuing the two-way goodwill relationship.

An American in Taiwan

Samuel Noordhoff, trained in plastic surgery in Grand Rapids, Michigan, is superintendent of the new Foundation 1,600-bed Chang Giang Memorial Hospital, Taipei, Taiwan, Republic of China. When asked how he got to Taipei, he wrote in 1977:

In 1959, I responded to a request for a surgeon of my church, the Reformed Church in America, feeling this is what God wanted me to do. I've stayed here because of the people and the challenges. Having talked Ralph Blockma into starting a plastic surgery program, I was his first resident. I greatly appreciate his training as he was a superb teacher and surgeon with excellent concepts in lip and palate surgery. A most interesting aspect of this work has to do with abandoned babies that we've operated on and then have seen adopted into American homes. It's great to get a Christmas card with the note that our little girl or boy's the smartest one in their class. It's unbelievable what love and proper care can do for a child, and I guess that's what makes it fun to be a plastic surgeon.

Roth in Korea

Robert F. Roth of Salem, Virginia, studied general surgery and plastic surgery at St. Luke's Hospital, New York, and Korean language at Yale University, after which he was commissioned a missionary of the United Methodist Church at Buck Hill Falls, Pennsylvania. From 1962 to 1972, he worked at the Wonju Union Christian Hospital in Korea, assisted Lew Jae Duk, trained by Kerwin Marcks, taught residents at the Yonsei-Severance Medical College in Seoul and, as consultant for the International Holt Adoption Program, operated on all of their cleft lip and palate cases. In 1966 he returned to the States to complete his plastic surgery training with Dick Stark and George Crikelair, and at the University of North Carolina. These are his reflections in 1977:

In the mission field, the surgeon trained and gifted in plastic and reconstructive surgery has limitless, almost luxury options for service and fulfill-
ment. One soon appreciates that all surgery in the broadest terms is "plastic." Even the purely "cosmetic" is available as a "money crop" to support reconstructive surgery for indigent patients and for non-paying projects in Public Health, the bedrock of all mission medicine. At first, the realization that for one or two million people, you are the only qualified person to perform a cheilo- or palatoplasty can be an awesome challenge. Yet even someone with a minor blemish has trouble going to school, finding a job and getting married in Korea. Someone with an un repaired or poorly repaired cleft lip or palate had best crawl into his grave as early as possible. So the answer, of course, is to close a cleft, reach one, over and over again. The sooner you make yourself dispensable, the finer your service.

While the vast majority of cleft lip patients in developed countries are corrected by three months, be prepared overseas for a patient from 6 hours to 60 years of age. Boys characteristically will be brought sooner for repair than girls. In some rural communities it is not until a girl reaches marriageable age that "it is time to repair the lip." The female palate may never have its time, since silence is considered a virtue in the Far East.

Be prepared too for some unexpected cultural factors. Multiple births are veiled in superstition as animalistic, if not cursed. Coupled with a very real handicap of no supermarket supply of milk, the new mother will give almost exclusive preference to the stronger of twins, especially a male newborn. Should one of the twins have a congenital malformation, particularly a cleft lip/palate, a cultural triage of infanticide by neglect is accepted practice. On one occasion, despite performing a cheiloplasty for a newborn twin, the emaciated, boil-studded body of the dead infant was returned to the hospital four weeks later, as if to prove it was his fate, surgery or none. A derisive, taunting, "onchungee-ya, onchungee-ya" ({"\text{"onchungee-ya, onchungee-ya"}} "Harelip" in Korean) is a severe condemnation for anyone with or without the anatomic blemish. Whenever possible, to pull a child out of that pit of despair is an eternal moment frequently under-appreciated in Western medicine.

Among surgeons, the plastic surgeon is tempted to sport a certain degree of hubris, since the techniques in his fingertips embody dramatic creative change. The missionary plastic surgeon is also tempted because his creative efforts are magnified by the unsophisticated eyes of nationals overseas and could lead to a delusional perception of self as the central figure in life's Sistine imagery, so familiar to us all. The temptation is there, but it is only a fool who takes a bite. To be truly effective as a missionary doctor, one must have a sense of call, a live faith and a right spirit.

Barsky Unit in Vietnam

The most famous foreign program was the National Center for Plastic and Reconstructive Surgery, which consisted of several
interconnected buildings on an acre of land in Saigon, Vietnam. This center was established by Arthur J. Barsky of New York and designated by the minister of health as the Barsky Unit. It began operation in July 1968 and continued until obliged to evacuate in April 1975. Plastic surgeons from all over the world volunteered to work and teach in this unit. During its six-year existence, 6,288 patients were admitted and another 21,842 were treated as outpatients. A total of 2,033 operations were carried out at this center: 593 cleft lip operations, 140 cleft palate and 1,300 cleft lip and palate. Speech therapy training was introduced in Vietnam for the first time.

**A Latin American program**

Project Interplast (International Plastic Surgery Program) began in 1965 and has sent plastic surgery teams into backward Latin American countries as well as transporting patients from these countries to Stanford Medical School for surgery. Educator-surgeon-scholar Donald Laub, director of Project Interplast, recalls his first case:

Nine years ago, Antonio Victoria, a fourteen year old boy from Mexicali, was brought to Stanford by the Latin American Mission Project. The child was grossly deformed by a congenital cleft lip and palate—defects that in this country would have been repaired between the ages of one and three. Antonio's defects had made him a social outcast. His family thought they had committed a sin when they conceived him. When his deformity was corrected, he was able to return home and to lead a normal life.

**East Africa Flying Doctors Service**

Sir Archibald McIndoe, Michael Wood and Thomas Rees were in on the conception of this great program. Other plastic surgeons have served. One of them, David W. Furnas of the University of California, wrote in 1977:

My most consuming interest, outside of plastic surgery, is doing plastic surgery in developing countries where needs are great, many cases are unique challenges, the setting is romantic, and each day is an adventure. (These qualifications apply in considerable degree to Southern California, particularly if you drive any distance on the freeway). The paperwork is almost non-existent (Southern California loses!). One of the greatest joys of my life was working as a surgeon for the East Africa Flying Doctors Service in
1972–73 under Director General Michael A. Wood. It was here, under Mr. Wood's tutelage, that I saw plastic surgery in its pure form—surgery of the skin and its contents! On one's schedule one might have to repair some cleft lips, place a Küntscher nail in a femur, do a prostatectomy, take out an eight-pound ovarian cyst, repair a vesicovaginal fistula, do a cartilage graft for a collapsed leprous nose, and perhaps repair a hyena bite, a lion clawing, or a corneal tear from a thorn tree.

A high point each year now is returning to Kenya to continue this work (although I now stick to more conventional plastic surgery and leave the forays into the abdominal cavity to Mr. Wood)—nonetheless, the spectrum of pathology and challenge is always monumental.

THE EPITOME OF GOODWILL

Mammituppu is a very primitive island in the 350 San Blas island string that fringes the northern coast of Panama in the Caribbean Sea. Many of the Kuna Indians inhabiting this island were massacred by Spaniards 400 years ago, and since then they have distrusted foreigners, allowing no visitors. In 1958 missionary Roland Icke gained admittance to the island and spotted a young boy with a cleft lip. The boy, being the grandson of the chief, had been spared the usual practice of killing cleft infants by withholding food and fluids. Icke decided to use this cleft as a wedge to bring the Christian gospel to the island and invited Ralph Blocksma, who had been involved in missionary medicine since 1949 in Pakistan, to stop off on his way to Quito, Ecuador.

A visit to the island gained permission for the operation from the boy's father, but both grandfathers, who were medicine men, strongly opposed it. They said they had given the boy's mother the best possible prenatal care with their native herbs, medicine baths and chants—and in spite of this the child had been born with the deformity; therefore, nothing could be done. After much pleading by the boy's father, consent was granted. Under endotracheal anesthesia, the lip cleft was closed successfully, and as soon as the sutures had been removed the child was returned to Mammituppu. The entire village marveled at the miracle, and the patient's grandparents, the medicine men, stated that Dr. Blocksma must be a god, for certainly no man could have mended the boy in that manner. He was given the name of Rafael after the surgeon and brought six eggs as a token of his
appreciation. Thus the closure of a cleft lip finally opened the San Blas island Mammituppu to the teaching of Christian missionaries.

Extension in Panama

Daniel Gruver, born into a Kansas City Baptist missionary family serving in Alaska and Costa Rica, earned an A.O.A. key at Southwestern Medical School in Dallas and completed a residency at Gorgas Hospital in Panama. He then became the first doctor in the partially finished Marvel Iglesias Hospital in Ailigardi, San Blas, Panama, and for years was the only doctor and dentist for 30,000 Indians. In addition, he flies an ambulance plane, started a 100-acre farm, set up the first water supply system in San Blas, runs the town’s light system, created feeding centers to prevent kwashiorkor, and gives daily devotions in the Kuna language. As he wrote in 1977:

The Kuna Indians have an extremely high rate of congenital anomalies and the highest incidence of albinism in the world. The Kuna Indians’ high incidence of cleft lip, several times greater than anywhere else in the world (2% of births), causes the major part of my plastic surgery to be the closure of clefts. Although I have had no formal training in plastic surgery other than the several days in Jamaica in 1969 when I scrubbed with you, I have been able to make these babies acceptable to their families and have adopted a severe bilateral cleft which has had a preliminary adhesion. A baby born with a cleft here will be destroyed if not operated before discharge. I do not see clefts in adults. Since Cleft Craft I, the results of my surgery have greatly improved. I have a leave of absence during which time I hope to take one year of rotating general surgery and two years of plastic surgery in Miami.

While in training in plastic surgery in Miami in mid-1979, he told me:

In 1968 a drum of oil delivered to San Blas cost five dollars, but today costs 60 dollars. Therefore my first priority when I return is to get a windmill working to provide electrical energy for the hospital operating room, refrigerators, x-ray, lighting, centrifuge and autoclave.

AND SO . . .

The story told in Cleft Craft can be summed up in the cover boy who appears in detail on page 350 of Volume I, but whose spirit
lingers throughout Volumes II and III. He may be a twentieth-century American 4-year-old, but he stands for a child with a cleft of any country in any century. The genes he has inherited for brains and temperament will exert the greatest influence. The family, friends, socioeconomic situation and specific point in time and space with which he is presented will determine his treatment.

Here he is after surgery with his hair combed in front, obviously arranged only under parental duress, specifically for a visit to the doctor. His lip scar is no more noticeable than the scratch on the side of his nose from a scrap with the kid down the block. Thanks to centuries of surgeons, the evolution of this craft has made it possible to camouflage his cleft so that at the age of 19 he can take his rightful place among men, free to become whatever his abilities will allow—plumber, piccolo player, pilot, pediatrician or president.

At age 19 years he hopes to become a pilot.
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David Ralph Millard, Jr., was born at Barnes Hospital, St. Louis, Missouri, on June 4, 1919. He grew up in Asheville, North Carolina, becoming an eagle scout, gold palm. At Asheville School for Boys where he graduated cum laude, he received the Robert E. Lee award for scholarship, leadership and athletics, was named to the All Western North Carolina football team (at center), and was elected captain of the track team and president of his class. At Yale University he made the varsity football (coached by Gerald R. Ford) and freshman wrestling teams and was undefeated light heavyweight on the boxing team in 1940 and University heavyweight in 1941. He received his medical degree from Harvard Medical School in 1944 and interned in pediatric surgery under W. E. Ladd and R. E. Gross at Boston Children’s Hospital.

During World War II he attained the rank of lieutenant (j.g.) in the U.S. Navy and after the war pursued further extensive training as a surgical resident under Barney Brooks at Vanderbilt University Hospital, a trainee with Sir Harold Gillies of London, a resident under J. B. Brown, L. T. Byars and F. McDowell at Washington University, St. Louis, a fellow with C. L. Straith in Detroit, and as a senior resident under T. Cronin and B. Hardy at Baylor University, Houston. He served as chief plastic surgeon (rank: Major, U.S.M.C.) to the U.S. Marines during the Korean conflict.

In 1965 Dr. Millard was honored with a medal for his contributions in the field of plastic surgery by Komenius University in Bratislava, Czechoslovakia, and was awarded the Order of Distinction by the Government of Jamaica in 1976 for his reconstructive work in the West Indies. In 1978 he received the Asheville School Award of Merit, and in 1979 the Honors Award of the Florida Cleft Palate Association. He won the First Prize in the Senior Division of the International Scholastic Contest sponsored by the Educational Foundation of the American Society of Plastic and Reconstructive Surgeons for 1965 and 1968, and the Herbert Lipshutz Memorial Prize in 1976. He was appointed clinical professor of surgery and chief of the Division of Plastic Surgery at the University of Miami School of Medicine in

Dr. Millard holds memberships in numerous professional organizations, including the American Society of Plastic and Reconstructive Surgeons, the American Association of Plastic Surgeons, the American Society for Aesthetic Plastic Surgery, the American Cleft Palate Association and the Society of Head and Neck Surgeons. He is a corresponding member of the British Association of Plastic Surgeons and a member of the Committee of One Hundred. He was recently named to the Founders' Club of the University of Miami. In addition, Dr. Millard has served as president of the Educational Foundation of the American Society of Plastic and Reconstructive Surgeons (1970–1972), as associate editor of the *Plastic and Reconstructive Surgery* journal (1969–1975), and as a director (1973–1978) and vice chairman (1978–1979) of the American Board of Plastic Surgery.

In addition to *Cleft Craft*, Dr. Millard co-authored the two-volume work, *The Principles and Art of Plastic Surgery*, with Sir Harold Gillies, edited the *Symposium on Corrective Rhinoplasty*, and has published over 150 articles and book chapters. He presented the Gillies Gold Medal Lecture at the Royal College of Surgeons in London, 1971, the Edward P. Richardson Lecture at the Massachusetts General Hospital in 1974, and the George H. Monks Lecture at the Peter Bent Brigham Hospital and Boston Children's Medical Center in 1977. Volume I of *Cleft Craft* was awarded the R. R. Hawkins Award by the Association of American Publishers as the most outstanding book of 1976 in the fields of technology, science and medicine. His hobbies are water skiing, shooting and roping. *Sports Illustrated* reported a first when he spun a rope in a vertical loop while slalom skiing.

Dr. Millard says that the best thing that ever happened to him by far was "meeting and marrying the beautiful Barbara L. Smith" of Tulsa, Oklahoma, followed by the birth of their three children: David Ralph III, William Bond and Meleney Grace.
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