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. Jolleys 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 \( \beta \) 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 resulting 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 immediate 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 treatment 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.

\textit{Wassmund}

In a 1973 book by Schuchardt, Steinhardt and Schwenzer, a chapter by Luhr, Hölje 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.

\textit{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 \textit{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.


EGYEDI ADMITTED:


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 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 join had obtained a blood supply, the tongue attachment was divided and the flap was swung up to close the fistula in the palate.
In 1970 in the *Annals of Otology, Rhinology and Laryngology*, Raymond Massengill, K. Pickrell and R. Mladick of Duke University endorsed the anteriorly based dorsal tongue flap of Guerrero-Santos for a two-stage closure of anterior fistulae and reported four cases, one of which was illustrated as shown. They concluded:

Previously, large anterior palatal defects have been closed by a prosthesis 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 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.

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
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 palatal 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.
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
pharynx. 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 buccoalveolar 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 × 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.
AXHAUSEN

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.

MACOMBER

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

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 inquiring 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 Čupar 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. Čupar 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-
neuver to make the direct oral entrance for pedicles more palatable.

**SCHUCHARDT**

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.

**NEUNER**

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 musculo-mucosal 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 uncial 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 $\frac{3}{2} \times 1\frac{1}{2}$ 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 Blocksmna of Grand Rapids, Michigan, in 1963 suggested silicone implants for augmentation pharyngoplasty. In 1968 Blocksmma 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 dermafat. Out of 262 surgeons who perform surgery for velopharyngeal 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 pan-endoscopic 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 intracordial 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 Blue-stone, 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, TEFLOM 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 X 2 X 0.6 cm.) and a small one (1.5 X 1 X 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 × 14 × 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. 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 far too low to be effective, as demonstrated by Berkowitz with x-ray films showing palate at rest, vocalization of u 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.
53. Palatal Obturators

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 palate 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.

C O O P E R

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.
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 prosthodontist

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 un repaired 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.

**REST**

**PHONATION OF [u]**

![Diagram of resting and phonating positions of velum](image)

**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."

Variations in Combined Use of Obturator and Pharyngeal Flap

In 1958 in the American Journal of Surgery Richard Webster, with Quigley, Coffey, Querze and Russell of Brookline, proposed the early use of an obturator to close the cleft of the hard palate in order to avoid surgery of this area until the age of 5 to 8 years, as earlier surgery was coming under scrutiny as a possible cause of maxillary growth retardation. At the same time, in order not to impede speech development, Webster closed the soft palate with the aid of one of his wide, superiorly based pharyngeal flaps.

In 1973 Tomohiro Shigematsu of Tokyo Dental College, after an extensive study, concluded:

The above results indicate that pharyngeal flap surgery and speech aid improve the hypernasality and dysarthria of cleft palate patients with nasopharyngeal incompetence. Speech aid is less effective than pharyngeal flap surgery for improving speech, but it seems to be useful to set a speech aid before pharyngeal flap surgery in order to improve postoperative speech results.
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 obturators 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.