The Pin-Retained Prosthesis in Cleft Palate Orthopedics

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Treatment of the infant with cleft lip and cleft palate has been associated with many marked advances in recent years. These can and should be incorporated into the treatment of these patients if we are to obtain the best possible results. The basic contribution to modern care was made by an orthodontist, McNeil of Glasgow, who first demonstrated that the maxillary segments could be moved into more normal relationships with the mandibular arch through the use of acrylic bite plates (*4*).

For over one hundred years, orthodontists have appreciated the effects of abnormal or unbalanced lip and cheek musculature in producing serious alterations in the facial skeleton and significant disturbances of the dental occlusal relationships. Davis (*2*) was one of the pioneers to point out the significance of these relationships to the cleft lip and cleft palate problem specifically, and over thirty years ago made an appeal for closer cooperation between plastic surgeons and orthodontists in these cases.

The purpose of our therapy of cleft palate patients is the early and continued separation of the oral and nasal cavities by a prosthesis in order to restore normal anatomy and function. As a result of this approach, more normal patterns of feeding, speech, dentition, hearing, and facial growth appear to be developed. In our opinion, this early mechanical restoration of the palate, simulating normal anatomy and assisting normal function, will greatly reduce, or perhaps eliminate, the need for treating the secondary problems. For example, the need for certain aspects of speech therapy will be reduced or eliminated through the transference from glottal stops to tongue-tip activity. The need for orthodontic treatment may be reduced by bringing the maxillary segments into proper relationship with the mandible and facial growth directed similarly toward the norm. Mechanical restoration of the palate permits normal use of the nipple for feeding and prevents, in large measure, regurgitation of food into the nasopharynx, with its attendant middle-ear problems. Finally, it is our feeling that the permanent in-

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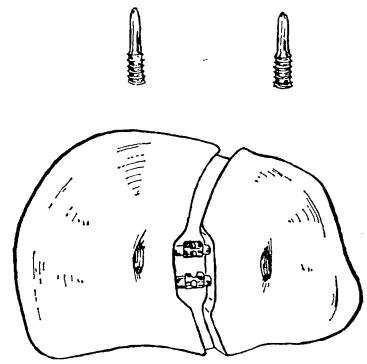


PALATAL VIEW
WITHOUT PINS IN PLACE

FIGURE 1. Palatal view of pin-retained expandable acrylic prosthesis showing pins.

sertion of this prosthesis until palatal repair is carried out is important, not only to bring constant pressures to bear in the sphere of maxillary orthopedics, but also to eliminate the necessity for active patient or parental cooperation and give reliable control for comparative studies.

With ten years' experience with the palatal bar as a background, the usefulness of an expandable acrylic applicance retained in the same fashion, by pins extending into the palatal bones, is now being explored. These devices (Figure 1) are fabricated on dental models of the patient's maxilla, using clear lucite plastic.

Method

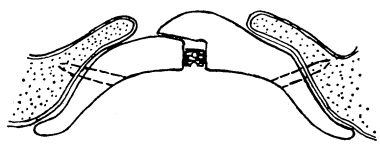
The cleft defect on the model is filled in with base plate wax, restoring the continuity of the hard palate. Holes are then drilled in the model and the pins, with the nuts in place, are inserted into the holes. Wax is flowed around each pin to secure it to the model. The expanding devices[1] are waxed to the model in their proper position. The position of the expanding devices is determined by the direction of the forces necessary to move the bone segments in each individual case. A thin strip of base plate wax, approximately 2 mm by 2 mm, is attached to the model in the center of the palate in an anterior-posterior direction, thus separating the prosthesis into two parts. At this time, the holes in the expanding screw are filled with wax to prevent acrylic from entering them. The periphery of the prosthesis is marked on the model with a pencil; following that, a

[1] From the Rocky Mountain Dental Products Company.

liquid separating-medium is painted on the entire model. The prosthesis is constructed with clear lucite acrylic using the brush technique. After the acrylic has polymerized, the prosthesis is removed from the model and a flat plane is ground on the tissue side of one of the halves of the prosthesis on the medial border. A separating strip of plastic or tin foil is applied on this plane and the other half of the prosthesis is extended over the plane. This allows the prosthesis to be expanded with complete closure of the palatal defect (Figure 2). Wax is removed from the prosthesis and the prosthesis is then trimmed and polished.

The use of a clear plastic in the prosthesis permits periodic examination of the palatal mucosa for any changes that might take place beneath it. Two retaining pins, extending horizontally through palatal bone, are used to maintain the prosthesis in the roof of the mouth. Care is exercised in positioning these pins in the prosthesis at the time of construction to avoid any damage to the tooth buds or to the roots of erupted teeth during insertion. The use of only two pins, one on the right side and one on the left, will not limit antero-posterior or lateral growth of the palatal tissues, but at the same time will maintain the prosthesis in close approximation to the hard palate. In addition, the periphery of the prosthetic appliance is terminated anteriorly and laterally on the sides of the alveolar ridges in order to avoid limitation of growth in these areas. Care is also taken to avoid pressure on the cleft margins in order to permit appositional growth of the hard and soft tissues there.

When the prosthesis is expanded in lateral width by turning of the screws, pressure is applied in a horizontal plane to the palatal and gingival tissues. In addition, some force is undoubtedly applied to the pins, tending to displace them inferiorly through the supporting osseous tissues. Certainly, such constant pressure could theoretically produce tissue necrosis, permitting inferior movement and displacement. This



CROSS-SECTION VIEW

FIGURE 2. Cross-sectional view of the pin-retained expandable acrylic prosthesis.

may take place, but has not yet happened, at least to the extent that it is recognizable clinically. The upward thrust of the tongue appears to more than compensate for this force, keeping the prosthesis firmly seated in close approximation to the overlying tissues of the roof of the mouth.

With such devices the alveolar processes can be positioned through screw, spring, or combined mechanism, with or without adhesions or complete repair of the lip. With the palatal bar only stabilization of the palatal segments was accomplished whereas, with the expandable acrylic pin-retained prosthesis, expansion, rotation, and even retraction of segments is possible. The bearing surface of the palatal bar was relatively small, resulting in a high concentration of pressure per unit area. With the palatal prosthesis, pressure is greatly disseminated. After satisfactory alignment of the maxillary segments, permanent stabilization can be obtained by bone graft if necessary. Positive continuing control of dental arch alignment is thus obtained, rather than merely the preservation of a static situation. Since the prosthesis can be removed from the mouth only by the surgeon or dentist, the cooperation of the child or parent is not so necessary in its daily use.

Discussion

The potentially valuable influence of the pin-retained expandable prosthesis on early speech development cannot be overemphasized. According to Irwin's (*3*) research, in the first few months of infancy the consonantal output consists mainly of glottal and velar sounds. These sounds, consisting of /h, ʔ, k, g/, comprise over 98% of the phonemic repertory in the first two months of life. Although this preponderance of back consonants continues to be demonstrated through the first nine or ten months, use of postdental, labial, and labiodental consonants increases markedly during the latter half of the first year. By the first birthday, these sounds represent the majority of the infant's articulatory output.

Undoubtedly, this normal shift from back-month to front-month articulation is the natural result of sucking behavior and eruption of deciduous dentition. Because the size and configuration of the normally growing hard palate keeps apace with a growing and active tongue, there is an easy transference to these new lingual-palatal and other antero-oral articulatory explorations. In fact, the activity of the tongue in these contacts contributes to the maturational expansion of the dental arch.

On the other hand, many cleft palate children present problems of dental arch configuration and speech that are markedly variant with normal maturational characteristics. Dental arch collapse is relatively common among these patients. In a study of preschool cleft palate children, Bzoch (*1*) found that the glottal stop and pharyngeal fricative accounted for over 57% of their substitutional errors. Sherman, Spriestersbach, and Noll (*5*) found more glottal stops and greater articulatory

defectiveness among cleft palate children than among children possessing functional articulational errors. In many cleft palate children there appears to be a mutually negative influence between palatal size and tongue tip articulation. Typical dental arch collapse does not invite intra-arch tongue-tip exploration because of increasing spatial limitation. Consonant with this fact, the lack of a counteractive lingual force on the intra-arch aspect fails to contribute toward prevention of arch collapse from extra-arch muscular forces.

This prosthesis helps the infant to learn to make normal speech sounds. Pilot observation of infants fitted with the pin-retained expandable prosthesis lends convincing proof of its excitatory effect on tongue-tip activity. Not only is normal sucking behavior achieved by means of tongue-tip elevation during feeding, but considerable exploratory tongue-tip behavior is observed aside from feeding periods. There is also an impressive use of babbling sounds in the infants we have observed. Implications of such early preverbal vocalization for later speech and language are obvious. According to Bzoch (*1*), 50% of the cleft palate children that he studied were described by their parents as having been delayed in such preverbal speech behavior as crying, babbling, and comfort sound. It seems reasonable that early cooing and babbling will enhance language development. Moreover, the early tongue-tip activity displayed by our prosthetically fitted infant patients should pay rich dividends in later articulatory development. Although sounds such as /t, d, s, z, ʃ, ʒ, tʃ, dʒ/ normally require reasonably adequate velopharyngeal valving, they also require contact between the tongue-tip or tongue-blade and the alveolar ridge or hard palate. Mature articulation of these sounds is at least partly explained by the extent to which lingua-alveolar and lungua-palatal contacts are exercised. The pin-retained expandable prosthesis appears to enhance this kind of motor exercise.

The pin-retained expandable prosthesis has now been used in a number of our cleft palate patients of different types and age groups. The following patients are reported in detail in order to demonstrate the efficacy of this mode of therapy.

Case Reports

Patient G., a white female, was admitted to the Medical College Hospital at four days of age. Impressions of the maxillary and mandibular arches were taken without anesthesia. From these dental study models the acrylic expandable prosthesis was fabricated. A removable nonexpandable prosthesis was utilized for about two weeks to acclimate the child. (In subsequent cases, we have found this to be unnecessary.) At the end of this period of time, the expandable pin-retained prosthesis was inserted under endotracheal nitrous oxide oxygen with fluothane general anesthesia. The postoperative course was uneventful; the child experienced no difficulties. After insertion of the pin-retained prosthesis, it was immediately recognized that the child was better able to take nourishment. It was no longer necessary to utilize the Asepto

syringe with soft rubber catheter in feeding, and the child was readily able to make use of a nipple with an enlarged opening. During the postoperative course there was no evidence that the prosthesis was associated with an irritant effect of any kind.

This expandable pin-retained prosthesis contained two jack screws, one incorporated into its anterior aspect, and the other in the posterior. By expanding the anterior jack screw more than the posterior, the alveolar segment on the cleft side was rotated laterally. Thus, expansion and rotation were obtained simultaneously. The screws were adjusted, that is, expanded, approximately one-half revolution per day (one revolution expands 1 mm), until the segments were moved into the desired position. This was accomplished in about two weeks. A lip adhesion, involving the floor of the nostril for the most part, was carried out at this time to bring a light compressive force to bear on the arch. The patient was discharged from the hospital and returned about one month later for examination and the taking of dental impressions. The dental study models taken at three months of age were compared with those taken at two months and at three weeks. The results of these comparisons are shown in Figure 3.

Patient S., a white male with Type III cleft of the palate associated with complete cleft of the lip, was referred to our care at five months of age. Shortly thereafter, under general anesthesia, the pin-retained expandable prosthesis was inserted and lip repair carried out. Figure 4, left, shows the maxillary segments before treatment, and Figure 4, right, after the pin-retained prosthesis had been in place for five months. It is to be noted that the maxillary arch has assumed a more normal contour and the alveolar cleft has all but disappeared. This prosthesis will be retained in its present position with periodic expansion, as necessary with growth, until the palate is repaired about 18 to 24 months of age.

Patient McE., a white male with Type IV cleft of the palate and a bilateral complete cleft of the lip (Simonart's band on the right), was referred to our care at one month of age. Shortly thereafter, under general anesthesia, the pin-retained prosthesis was inserted and a lip adhesion was carried out on the left side because the vomer and premaxillary segment of the alveolar ridge were deviated to the right. Figure 5, left, shows the deviation of the vomer and pre-

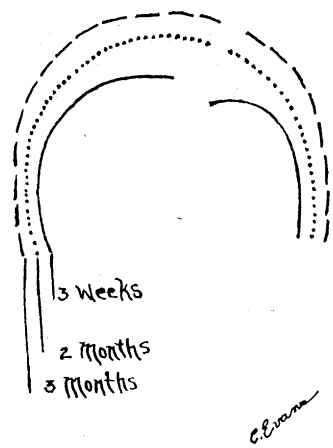


FIGURE 3. Tracings of the alveolar ridge of a patient treated with the pin-retained expandable acrylic prosthesis, at ages 3 weeks, 2 months, and 3 months.

maxillary segment of the alveolar ridge to the right, prior to treatment. Figure 5, right, demonstrates the insertion of the pin-retained expandable prosthesis.

At the time of insertion of the prosthesis, lip adhesions were carried out, as seen in Figure 6, left. This procedure was intended to put gentle pressure on the premaxillary segment to move it into its normal anatomical position within the maxillary arch. On the right in Figure 6 one can see the result of this pressure six months after operation. The premaxilla has been almost completely returned to its normal position.

FIGURE 4. Maxillary segments before treatment, left; maxillary segments after pin-retained expandable prosthesis had been in place for five months, right.

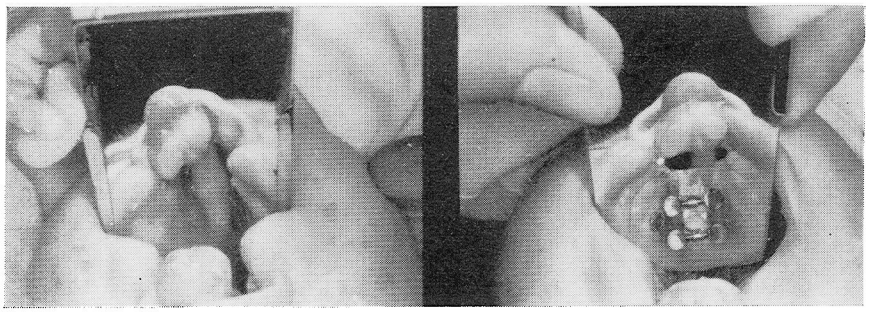


FIGURE 5. Left, deviation to the right of the vomer and premaxillary segment of the alveolar ridge prior to treatment; right, the pin-retained expandable prosthesis in place.

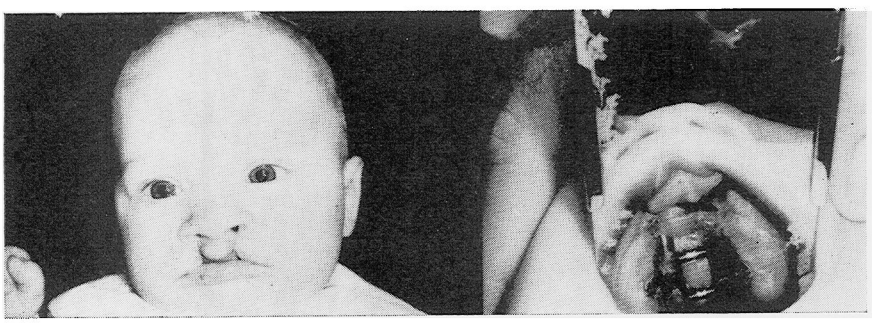


FIGURE 6. Lip adhesions are shown on the left; right, the premaxillary segment has assumed a near-normal anatomic position in the dental arch.

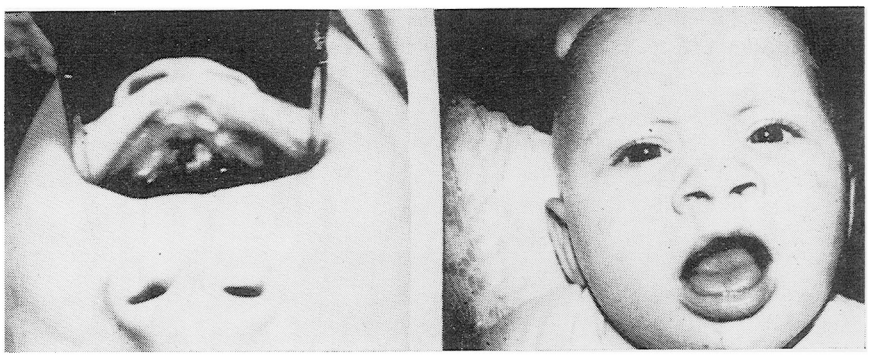


FIGURE 7. The maxillary arch after bone grafting, left; the final results after lip repair, right.

After the maxillary segments were brought into satisfactory alignment, bone grafting was performed in the cleft defects to stabilize the maxillary arch.

The final results of the stabilized arch form and lip repair are seen in Figure 7.

The pin-retained prosthesis has been used in twelve patients and has been retained in position for as long as 24 months with no evidence of irritation or infection.

Conclusions

As a result of our experience, it has become evident that the pin-retained expandable prosthesis is most versatile in its application to cleft palate treatment. The advantages of this prosthesis may be listed as follows: a) mechanical closure of the cleft, permitting more facility in taking nourishment and decreasing the amount of food entering the nasal cavity and naso-pharynx; b) rapid positioning of the maxillary segments; c) mechanical closure of the cleft, permitting anterior tongue thrust which balances the compressive forces of the lip musculature and also stimulates growth; d) mechanical closure of the cleft, permitting anterior tongue-tip explorations to stimulate the early development of articulated speech; e) the compressive effect of the tongue on the appliance, stimulating growth at the cleft margins and therefore reducing the size of the cleft; f) a more normal facial contour, resulting from more anatomical positioning of the maxillary segments and vomer; g) a reduction in responsibility on the part of both patient and parents for the insertion and use of the device; h) constant maintenance of the prosthesis in the desired position, eliminating displacement into a nonfunctional position; i) reduction of the nasal quality of the speech; and j) elimination of parental anxiety associated with external retention and fixation devices, insertion and maintenance of bite plates, feeding difficulties, and general appearance.

Summary

A technique for mechanical closure of cleft palate by pin-retained prosthesis is described and several case reports are presented. In our

opinion, the pin-retained expandable prosthesis moves the maxillary segments rapidly, especially in the infant, and reduces the number of prostheses found necessary with previous methods. In addition, with this regimen, a mechanical repair of the palate is instituted, permitting the child to suck and eat more naturally. Also, food is prevented from entering the nasal cavity until the palate is repaired, thereby reducing the incidence of ear infection. This course of treatment adds to the comfort of both the baby and the parents.

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