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Early Maxillary Orthopedics for the Newborn Cleft Lip and Palate Patient

An Impression and an Appliance

A detailed description of the fabrication and use of a maxillary orthopedic prosthesis for the newborn cleft palate patient, from impression through parental management of the appliance.

KEY WORDS: CLEFT PALATE, NEWBORN, MAXILLARY ORTHOPEDICS

The successful early involvement of the orthodontist in the treatment of clefts of the lip and palate is becoming a fact of life. In many areas around the world a cleft lip and palate infant comes into the world only to find a tray of alginate impression material waiting to be placed as the introduction to a procedure which has become known as EARLY MAXILLARY ORTHOPEDICS. A primary objective of this therapy is the guidance of the separated segments of maxillary alveolus into a semblence of arch configuration.

The procedures (JACOBSON AND ROSENSTEIN 1965, 1967, ROSENSTEIN 1969, 1974, MONROE AND ROSENSTEIN 1971) and the results of long-term studies of the procedures at Children's Memorial Hospital in Chicago (ROSENSTEIN ET AL. 1972, WACHS' 1972, ROSENSTEIN 1975, ROGERS 1978, ENANY 1981) are now a matter of record. The first sixteen consecutively treated orthodontic patients in our sample have now reached puberty and their maximum periods of growth, enabling us to compare them with other similar age groups of treated cleft lip and palate patients and non-cleft palate patients. (ROSENSTEIN ET AL. 1982).

Placement of an autogenous alveolar bone graft seems to offer three significant benefits:

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1 Prevention of collapse of the anterior portion of the arch as the smaller maxillary segment slides behind the larger
2 Allowing the eruption of teeth into the graft site
3 Allowing the midline adjustment that is so necessary to minimizing the asymmetry typical of treated cleft lip and palate

Orthodontics is involved in this treatment from beginning to end, even though conventional orthodontic appliances may be used for only a short period.

The sequence of events used by our team since 1966 is as follows:

- An impression for a study cast of the maxillary arch at one to two days of age.
- Fabrication of a combination soft and hard acrylic *passive* maxillary orthopedic appliance.
- Placement of the appliance and surgical closure of the lip as soon as the birth weight has stabilized. This is usually at ten days to two weeks of age.
- Guided molding of the maxillary arch segments follows, to the point of closely achieving a butting of the segments. At that time, approximately nine months of age, an autogenous *alveolar* bone graft is performed.
- Stabilization of the graft occurs in the next two months or so, using the orthopedic appliance as a splint. The palate is closed at approximately 12 months of age.

Surgical finesse is a critical factor in the quality of the result, as is the orthodontist's involvement. The early use of the appliance, followed by later limited and comprehensive orthodontic treatment, all contribute to the resultant symmetry, function, and esthetics.

The initial impression and appliance are the foundation on which many later procedures are based. The success of the early treatment sequence often depends entirely on the retentive facility of the appliance, and the retention of the combination maxillary orthopedic appliance depends entirely on the maxillary impression.

The Impression

The quality of a cleft lip and palate impression depends on two factors — complete inclusion of the lateral maxillary segments with a good reproduction of the mucobuccal fold, and adequate extension of the impression into the cleft area. The impression must extend into the nasal chamber and every available undercut. It is these undercuts that provide the retention capability of the appliance.

As with any impression, the tray size is very important. A set of perforated custom acrylic trays of different shapes and sizes, both unilateral and bilateral, can be easily made from different size casts (Fig. 1), or size and shape can be roughly estimated and trays individually trimmed and perforated with a large round bur. As an alternative, manufactured metal trays of different shapes and sizes may be modified as required.

The tray is carefully fitted (Fig. 2) so that it is wide enough for good lateral coverage, and long enough for good antero-posterior coverage. The posterior limit need be only the maxillary tuberosities. The anterior border is not critical, as the impression material is usually pushed forward far enough to cover the anterior structures as the tray is seated.

The tray is then rimmed completely with a utility wax bead. This gives additional bulk to the material in the lateral mucobuccal fold, and even more important, forms a posterior dam to prevent the impression material from being expressed posteriorly as the tray is seated.

At Children's Memorial Hospital in

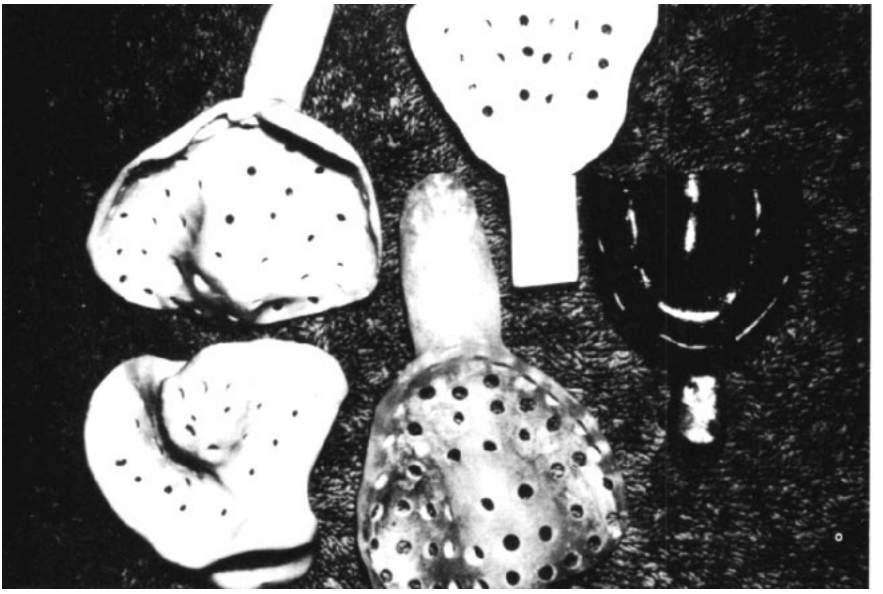

Fig 1 An assortment of custom-made perforated acrylic trays

Fig. 2 Fitting tray for adequate lateral and antero-posterior extension

Chicago, we usually take the impression in the hospital crib, which provides a good work surface at a convenient height. With both sides of the crib lowered, it is easy for a nurse, or preferably the mother of the child, to assist in the procedure. We have generally found that a mother who has assisted in the impression phase is much less afraid of handling the appliance later. It is well that she become involved early. At the time of the impression, the child is not anesthetized or premedicated, but should not have eaten for at least two hours.

Adequate suction apparatus should be available as a safety precaution, in the event that a piece of alginate is torn from the impression as it is withdrawn. This can be easily and quickly removed with a broad suction tip, avoiding the possibility of aspiration of the fragment. In our experience, the usual wall suction in hospital rooms proves inadequate in strength; we much prefer a good portable dental suction unit, which we find can effectively remove an impression fragment from an undercut, most times without tearing it further. This also provides us with the option of taking the impression anywhere that a crib, table, or dental chair is available, depending on the age of the patient. Of course, once the palate is closed, there is no need for the suction apparatus.

A color-timed alginate impression material is used. This lets the operator know exactly when the mix is ready for placement, so that the impression will be ready for withdrawal within 15 to 20 seconds after placement of the tray. Usually one scoop of powder, lightly packed, is sufficient for most of these young children. The water should be slightly warmer than room temperature to accelerate setting.

As the mix is first briskly spatulated, it turns a dark purple color, gradually lightening to pink. The tray is loaded at this time. The mix should feel rather thick in consistency, and is usually placed in the tray so that most of the bulk is in the center. This insures that there is enough material to provide a good impression of the important undercut areas in the cleft site. When the mix becomes white, the operator has approximately 30 seconds before it will be completely set.

The filled tray is inserted while the infant is lying back in a *horizontal* position (Fig. 3), to allow the best view and access. As the tray is inserted, some of the material will be expressed forward to envelop the premaxillary area. When the tray has been seated properly, the baby is raised to a sitting position. It is during this stage that assistance, usually by the mother, is quite necessary. The baby will now be crying quite actively, which is the best indicator for the operator that the airway is clear.

As the impression sets, the child is seated upright, with the weight of the head supported on the finger of the operator beneath the tray. In this position, the mandible is free to move as the child cries, and the airway is kept open. If the child is tipped too far forward, the mandible may be forced against the chest, making breathing through the mouth impossible.

At this point, since the nasal passage exposed by the cleft is blocked by impression material, the child may become slightly cyanotic, as evidenced by darkening of the facial coloration. In the 15 to 20 seconds that the tray is in place, this should cause no real problem other than apprehension in the operators.

Withdrawal of the impression is accomplished by the fast snapping action typically used for impression removal. The first order of business is to quickly check the impression for any areas where portions of the impression may have been torn away. Next, the cleft areas are ex-

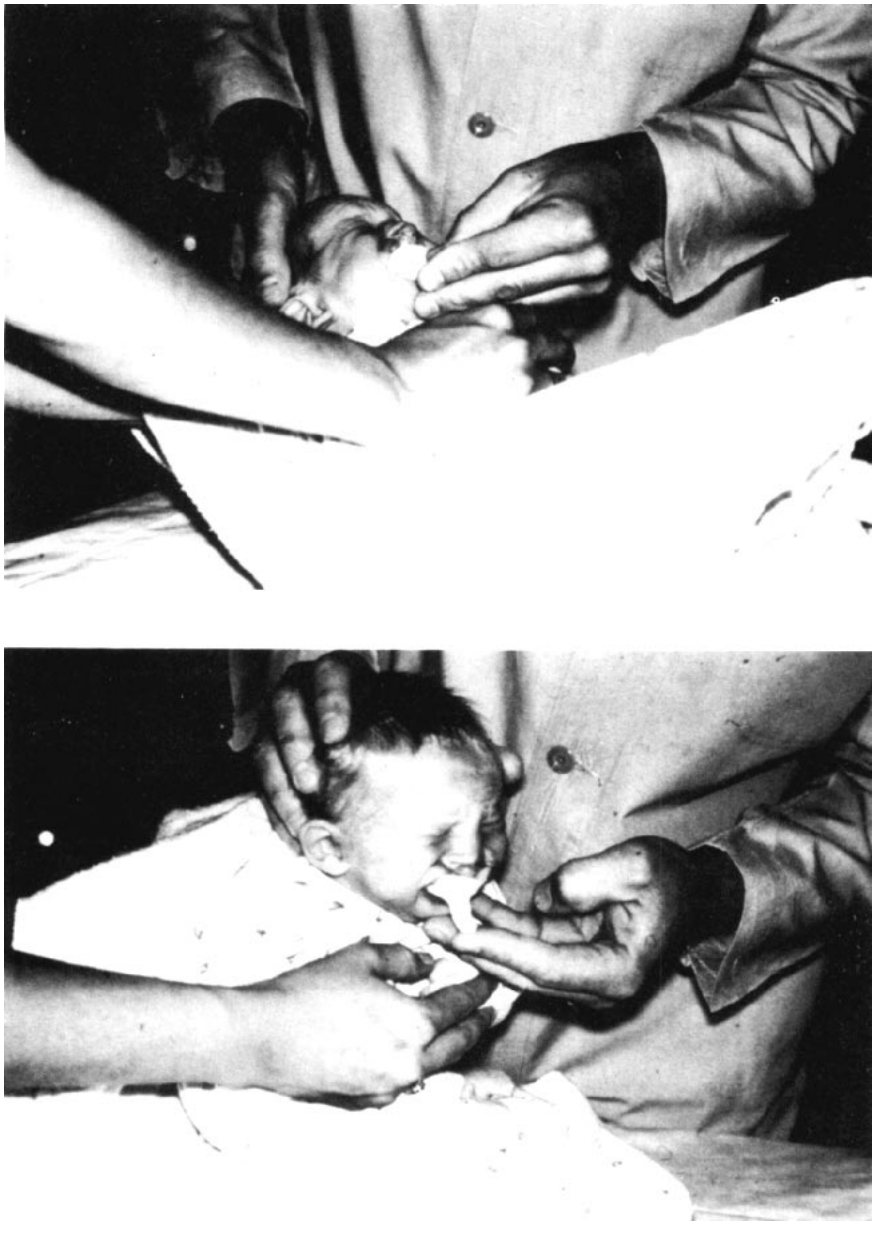

Fig 3 The loaded tray is inserted with the infant in a ***horizontal*** position for best access and view,
then raised to a sitting position while the impression sets. The weight of the head is supported on the operator's finger beneath the tray, with the mandible free and airway open.

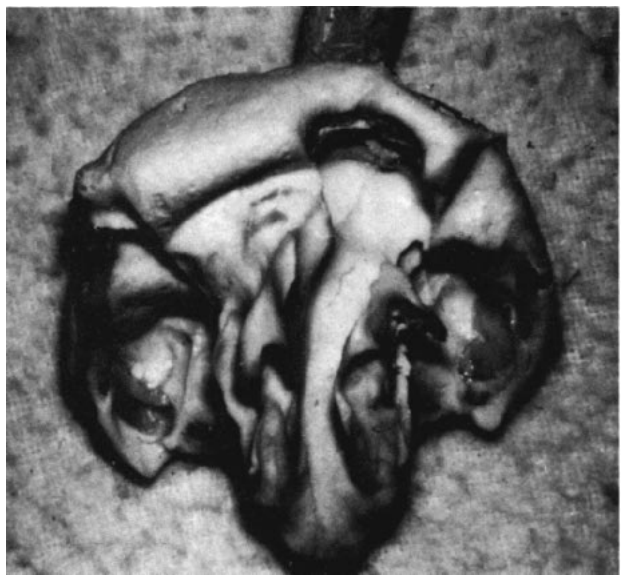

Fig 4
Impression, including complete maxillary segments

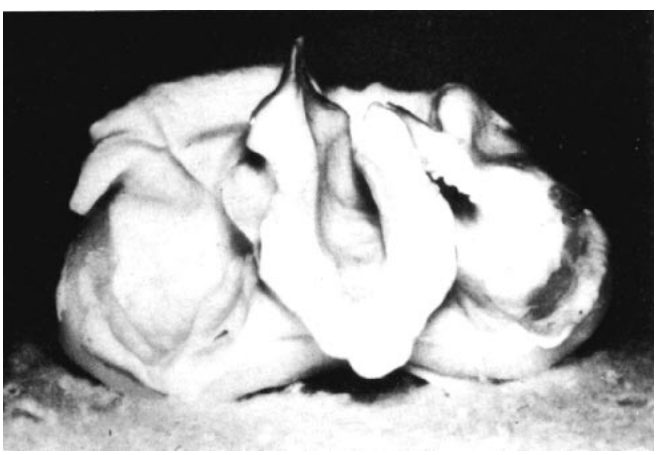

Fig 5
Posterior view, showing extension into the cleft to include critical nasal undercut areas

amined for any small fragments of the impression material, which are removed with the suction tip.

The resultant impression (Fig. 4) extends well into the undercuts in the cleft area, and also includes each of the maxillary segments in full detail. The posterior view (Fig. 5) shows the extension along the vomer, the central trough, and the extension into the nasal chambers on each side, including the nasal undercut along each of the lateral maxillary segments.

The working cast is poured in stone (Fig. 6). The necessary clarity and detail of the maxillary structures are possible only with an impression of this kind. The completeness of the lateral maxillary segments, with all potential undercut areas,

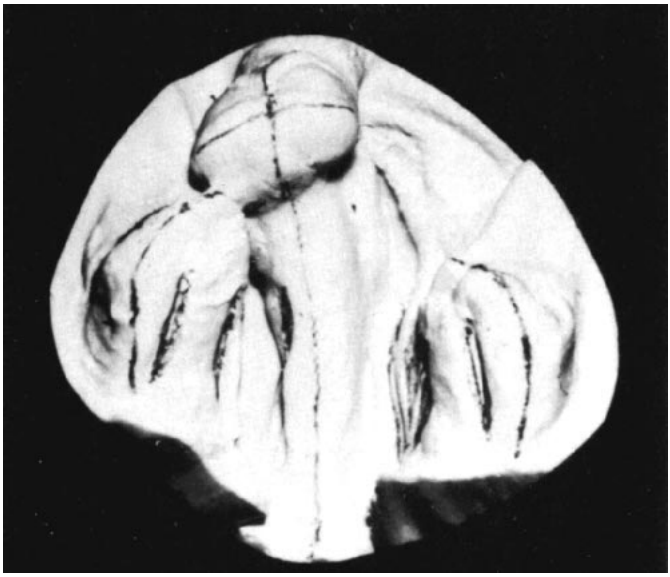

Fig 6
Stone working cast, showing detail of maxillary structures

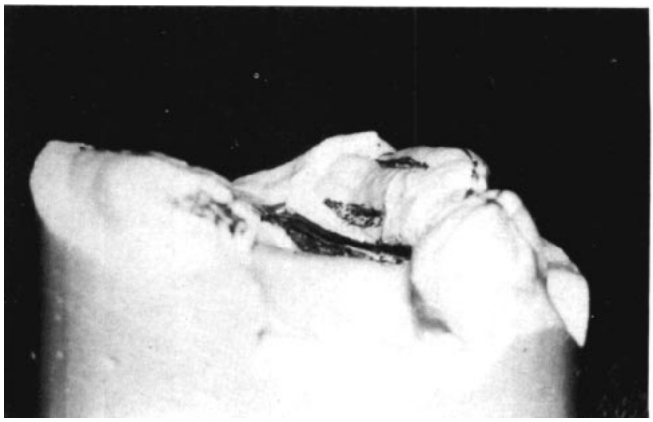

Fig 7
Undercut areas above the palatal shelves, which provide most of the retention for the appliance

is critical, as they will be completely responsible for the retentive facility and success of the appliance. The superior surfaces of the palatal shelves of the maxillae, just below the inferior turbinates, supply the major undercuts for the retention of these appliances (Fig. 7).

WHAT IS THE GENERAL ORTHOPEDIC FUNCTION of the appliance to be made from this cast? It is usually a *passive* role, that of maintaining the lateral width of the maxillary segments after lip closure. Too often, if this width is not maintained in a bilateral cleft, the lateral segments move medially in response to the force of the newly-closed lip, and these segments are then often trapped lingual to the premaxilla (Fig. 8). This, of course, predestines the bilateral crossbite so often seen in these cases.

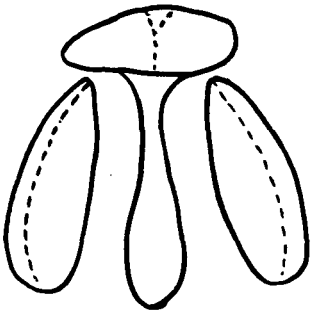

Fig 8 Diagram of the usual alignment of segments in a bilateral cleft if the width across the lateral segments is *not* maintained after surgical lip closure

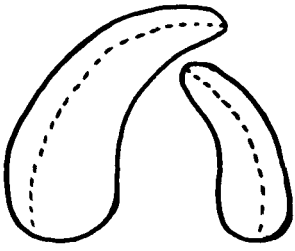

Fig 10 Diagram of most common arch alignment in unilateral cleft if posterior width is *not* maintained after surgical lip closure

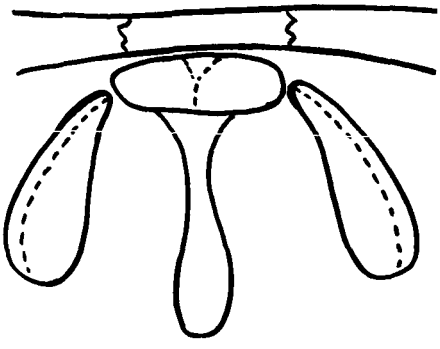

Fig 9 Diagram of alignment objectives in maintaining posterior width after closure

ON THE OTHER HAND, if the lateral segments are *held in position* by the maxillary appliance, the premaxillary segment responds to the lip pressure with lingual movement, probably through reshaping of the vomer and nasal septum. Hopefully, this movement will be *between* the lateral maxillary segments (Fig. 9). After the segments are thus aligned, an autogenous alveolar bone graft may be placed to stabilize the segments in the improved arch form.

In the unilateral cleft lip and palate patient, arch realignment with unguided molding of the segments following lip repair is often unfavorable (Fig. 10). In our opinion, this is a precursor to the unilateral crossbite so often seen. The objective of the passive appliance in these cases is to maintain the posterior width of the maxillary segments, as seen in Fig. 11, allowing the pressure of the newly-closed lip to mold the larger segment only. The influence is toward arch alignment, rather than overlapped maxillary segments, many times with butting of the tissue at the cleft (Fig. 12). Again, this may be later stabilized with an autogenous *alveolar* bone graft to establish maxillary integrity.

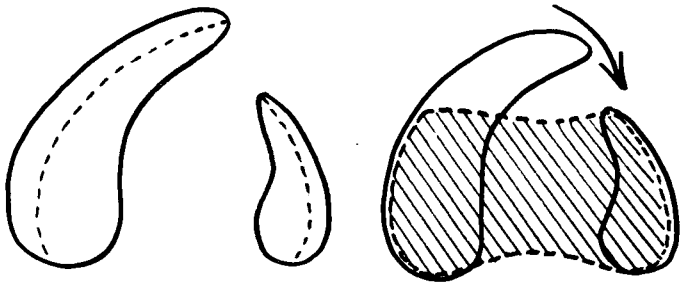

Fig 11 Diagram of unilateral cleft before surgery (left) and controlled "molding" of the larger segment after surgical lip closure (right)

Some cases require modification of these procedures. The most common situation is the patient who presents at birth with inadequate arch width even before the lip is closed, as seen in Fig. 13. In this case the appliance may be made active prior to lip closure, by merely embedding a spring-action jackscrew to create an active appliance. Activation at intervals of about ten days will move the smaller maxillary segment laterally, while the force of the newly-closed lip causes the expected molding of the larger segment, again improving arch alignment.

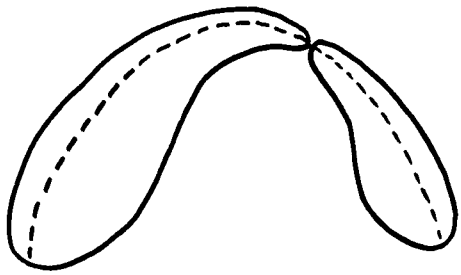

Fig 12 Ideal alignment, with butting of the tissues of the maxillary segments

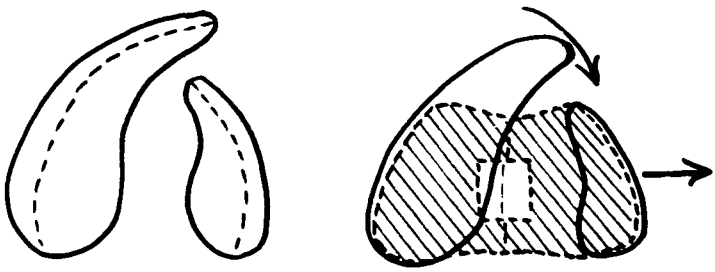

Fig 13 Unilateral cleft with inadequate arch width before lip closure, widened with a spring-tension jackscrew incorporated into the orthopedic appliance

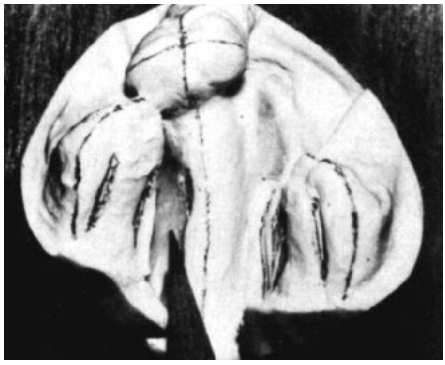

Fig 14 Study cast, showing areas most frequently waxed out to prevent intrusion of the soft acrylic into the nasal airway

The Appliance

As previously stated, the retentive facility of the appliance, and in turn the success of the early orthopedic procedure, depends greatly upon the utilization of every undercut area available. There are often small undercuts on the oral surfaces of the maxillary segments, but by far the most important undercuts are those formed by the palatal shelves of the maxillary segments on each side.

The area between the exposed nasal surface of the maxillary palatal shelf and the inferior turbinate usually proves most valuable in appliance retention. These undercuts are never waxed out.

However, the area representing the upper part of the nasal chamber is usually partially waxed out to prevent extension of the soft acrylic into this area where it could block the nasal air passage (Fig. 14). These infants have extreme difficulty breathing through the mouth, so a good nasal airway must be maintained. This is especially important during feeding.

The appliance is called a COMBINATION EARLY MAXILLARY ORTHOPEDIC APPLIANCE because it combines both soft and hard acrylics, and it may be either active or passive. The materials needed for its fabrication are:

1 Good separating medium, with cotton swabs or small brush for application.
2 Soft denture reline self-cure acrylic powder and liquid.
3 Clear self-cure acrylic.

The separating medium is applied liberally over the entire working area of the cast and into the undercuts. After a moment, a blast of air will thin it out and prevent puddling in the undercuts. Puddles of separating medium can prevent the soft acrylic from extending completely into the undercut areas which are essential for retention.

The self-cure soft denture reline acrylic is then applied directly on the cast, alternating liquid and powder applications, until every undercut area that might conceivably offer additional retention to the appliance has been overfilled slightly. This is especially important in the medial area.

It is important to remember that the more bulk of soft acrylic is used, the more flexible and resilient will be the material that extends into the undercut area. This improves retention.

The soft acrylic must be allowed to set completely for about 30 minutes before applying the hard acrylic. This protects the plasticiser in the soft acrylic from the hard acrylic liquid, which can reduce its flexibility.

After the soft acrylic has set, the hard, clear self-cure acrylic is applied over the lateral maxillary segments as well as the soft acrylic in the medial areas. This hard shell of the appliance should be rather uniform in thickness. It is at this stage that, if it is deemed necessary, an expansion screw may be placed in the midline of the palate and embedded in clear acrylic.

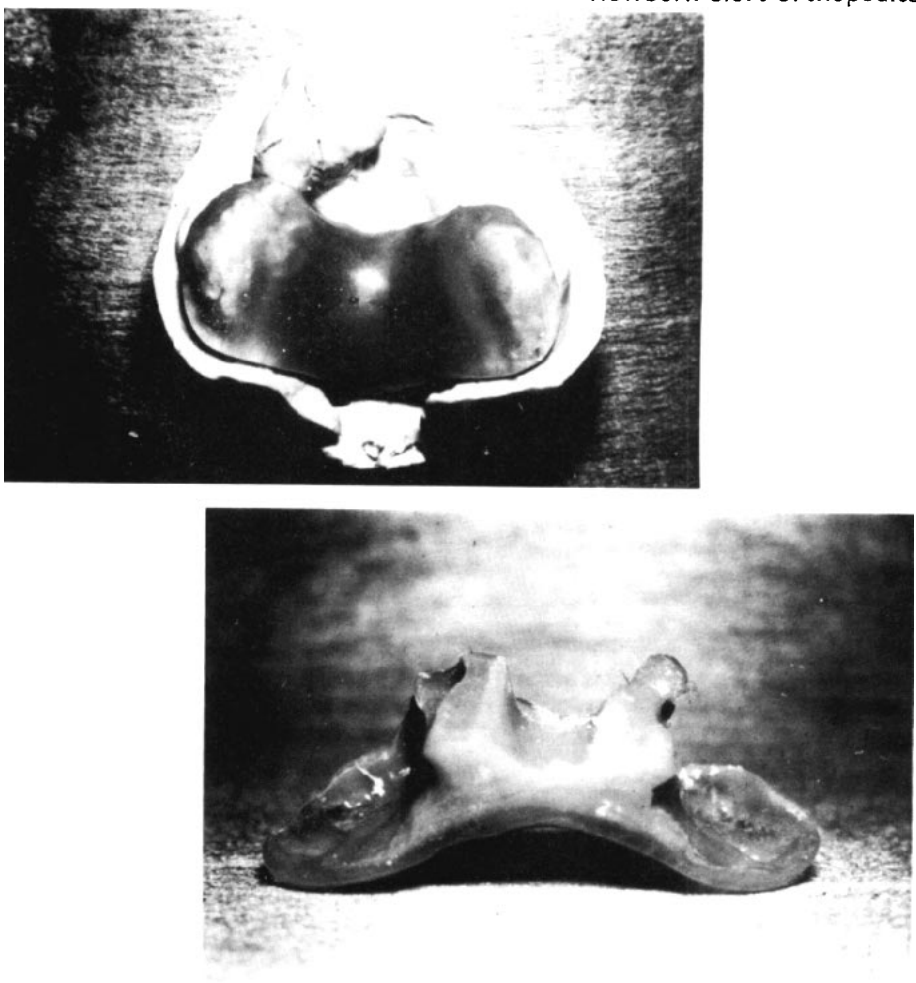

Fig 15 Finished appliance, showing form and extension. All undercut areas are soft acrylic.

When the appliance is removed from the working cast, a trimming line can be drawn, and the appliance trimmed and finished (Fig. 15). In this bilateral case, the appliance is trimmed so that the vomer is free in the anterior third, to make room for the bending response to the pressure of the newly-closed lip. Also, the base of the trough formed by the vomer may be enlarged to provide additional airway.

If the problem were a unilateral cleft, the appliance would be given the same general shape, allowing the premaxillary portion that is attached to one of the lateral maxillary segments to mold in response to lip pressure. The object is to allow this molding to occur without medial collapse of the lateral maxillary segments.

The buccal aspects of the appliance extend no more than 1 or 2mm past the

Fig 16 Appliance inserted prior to surgical lip closure. Proper seating can be verified by blanching of tissue seen through the clear acrylic shell

Fig 17 Two weeks after lip closure; the appliance is in place

crest of the ridges. The more revealing posterior view of the appliance shows the extension of the soft acrylic into the undercut areas of the open palate, where the retentive facility of the appliance lies.

The appliance may be warmed slightly to make the soft acrylic even more flexible, and then inserted (Fig. 16). There is slight blanching of the tissue of the maxillary ridges, which can be seen through the clear acrylic, indicating that the appliance is fully seated.

Fig 18 Four weeks after lip closure, showing progress in reorientation of the premaxillary segment

Follow-up

Let's follow this patient's progress just a bit farther to see the role of the appliance after the lip has been surgically closed (Fig. 17). The surgery was done three days after the appliance was placed. The appliance was not removed at all during the first week, to avoid disturbing the lip closure. It was worn continuously for the next few months, being removed only for cleaning.

Approximately four weeks after surgery (Fig. 18), some reorientation of the premaxillary segment is evident, with reduction in the alveolar void between the premaxilla and the left maxillary segment.

Mother will continue to remove the appliance twice each week for cleaning, but it is otherwise worn continuously. Retention is still good, and there is no evidence of tissue irritation beneath the appliance.

Dramatic changes in arch alignment can be seen approximately four months later (Fig. 19). This has been accomplished primarily by maintenance of the arch width by the passive appliance, while the premaxillary segment adjusted and reoriented in response to pressure from the newly-established muscular band of the now continuous lip. The patient is seen with the original appliance still in place, although the anterior portions of the lateral maxillary segments have been completely freed of their acrylic cover to allow for further molding.

The only retentive areas are now within the cleft site. The stability and retentive facility of the appliance, as well as the tissue tolerance, are still quite good. The premaxilla is well centered, and almost touches the tissue of the lateral maxillary segments on both sides. Comparison of the initial study cast with that taken after approximately four months illustrates the change in premaxillary position (Fig. 19). There has been little narrowing of the palatal cleft, because of the presence of the appliance. The improvement in arch form is due primarily to premaxillary reorientation.

The patient is now ready for an autogenous alveolar bone grafting procedure,

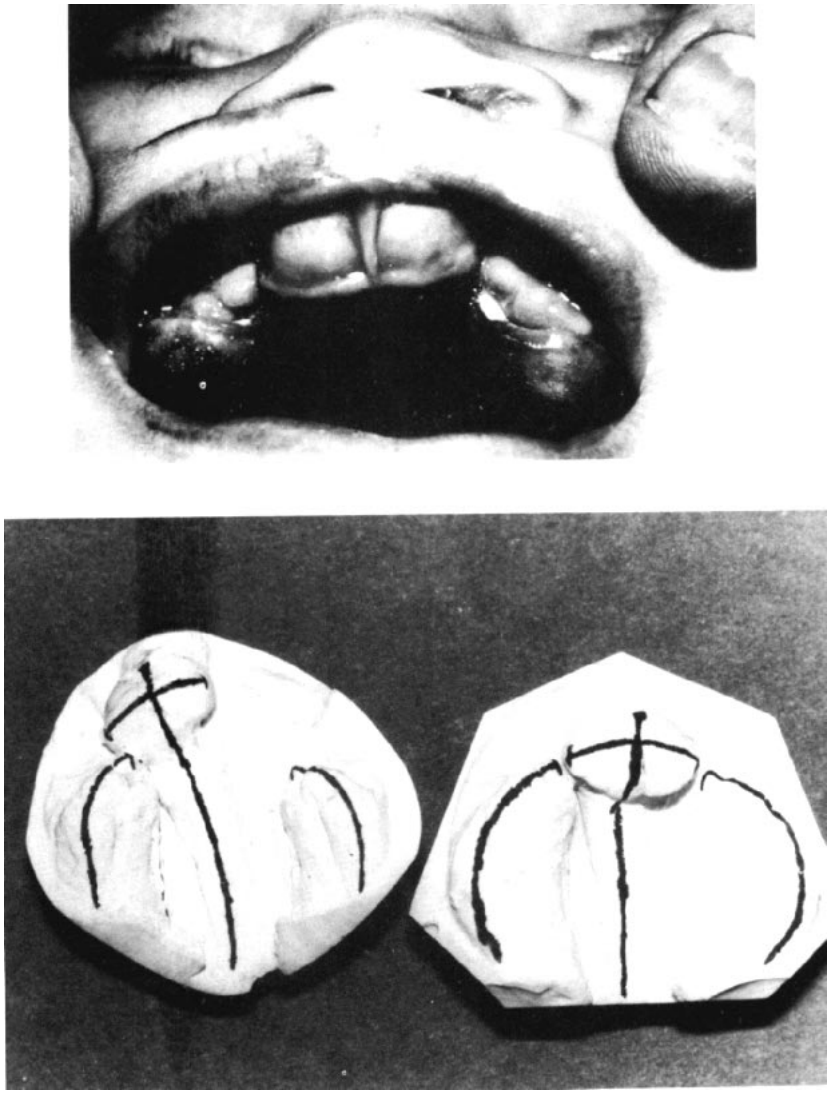

Fig 19 Arch alignment four months after lip closure

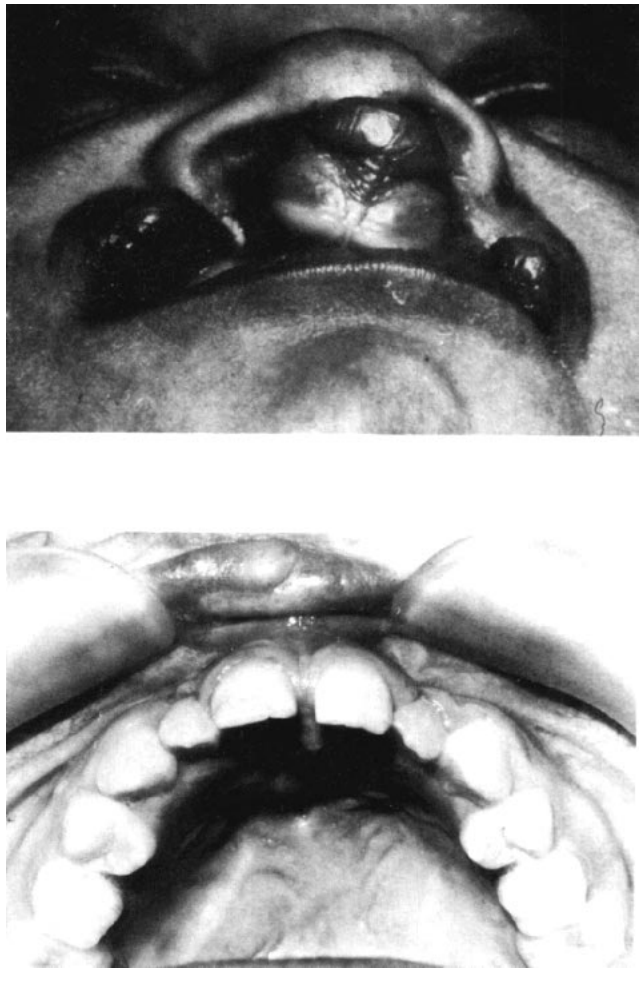

Fig 20 A patient with a bilateral cleft of lip and palate (Veau Class IV) at birth, and after eruption of the permanent dentition. There has been *no orthodontic therapy up to this point*; only removable orthopedic control and alveolar grafting. Note the alveolar bone thickness and tooth eruption in the graft sites.

Fig 21 The patient shown in Fig. 20 after a few months of comprehensive orthodontic treatment.

when the appliance will be trimmed and reinserted for stabilization. Approximately two months is needed for the graft to stabilize. After that, the appliance may be worn full time or used for feeding only.

The palate may be surgically closed at approximately one year of age, marking the completion of the early maxillary orthopedic phase.

A final case demonstrates the potential of early orthopedic involvement (Fig. 20). The severe cleft seen there shows the capability for arch formation and stabilization after use of the same appliance and following the same procedures outlined above. Teeth have erupted into a previous bony void with no early orthodontic intervention at all. A few months of comprehensive fixed orthodontic therapy yielded the result seen in Fig. 21.

Development of such a dental arch without active orthodontic intervention in a severe bilateral cleft lip and palate patient is certainly rare, but the fact that this can happen excites our orthodontic imaginations and strengthens the conviction that early orthopedic involvement with a small passive appliance can help yield results that were previously unattainable. Once the underlying bony structures have been normalized, all of the succeeding developmental stages can proceed along normal rather than abnormal paths.

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