Orthopedic Advancement of The Cleft Maxillary Segment: A Preliminary Report

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An intra-oral *appliance* has been developed that appears to exploit the anteroposterior adjustment potential of the *maxillary sutures* in the *unilateral cleft lip and palate* infant. In the treatment of the depressed *alar base* and dental arch malalignment in six infants, activation of the appliance produced a forward repositioning of the entire cleft *maxilla*, levelling of the alar bases, and improvement of arch form in a period of from 9 to 20 days. The new positions were retained for at least 10 days, and the appliance was removed one week before surgery. Continued evaluation of the method appears to be warranted.

Introduction

The depressed alar base in the unilateral cleft deformity of the newborn reflects a retroposition of the lateral maxillary segment (Millard, 1976) and anteroposterior asymmetry of the nasal notch and pyriform fossa. The attempt to attain a balanced nose usually comes in the course of initial lip and nasal reconstruction by the advancement of the alar base on the cleft side after it has been freed from its attachment to the maxilla (Millard, 1959, 1976). The maxillary asymmetry may remain, however, and, not uncommonly, some degree of depression of the cleft alar base may persist. Berkeley (1971) has suggested dealing with this problem by adding bone to the facial aspect of the maxilla to support the deformed ala and offset the maxillary deficiency. An ideal approach would be to move the entire infant maxilla forward by means of traction that would stimulate an adjustment response in the maxillary sutures (Latham, 1974). Such an advancement would improve alignment of the dento-alveolar arch (Figure 1). If this were accomplished in the infant prior to surgery, surgical treatment might result in more nearly normal anatomical relationships with minimal mobilization of facial tissues.

An intra-oral appliance designed to exert a forward force to the cleft maxilla has been used to treat anteroposterior facial discrepancy in six patients with unilateral cleft lip and palate. A preliminary report is presented.

Appliance Design and Method

The goal was to design an intraoral appliance, anchored on the non-cleft maxillary segment, that would exert forward force on the cleft maxilla and provide some control over the noncleft segment (Figure 1). In the present design, a screw 25 mm long was mounted anteroposteriorly on an intra-oral appliance made with acrylic polymer. The appliance was split down the midline, and the lateral bases were joined and stabilized by a posterior crossbar of stainless steel. The lateral bases pivoted freely on hinges at the ends of the crossbar and could move anteroposteriorly with respect to each other. The appliance was designed so that it could be secured to the palatal segments with stainless steel pins, two on each side. The pinning principle was essentially the same as described in 1970 by Georgiade.

The end of the screw fitted into a slot on the noncleft side of the appliance so that it could rotate freely. A nut threaded onto the screw locked against a wire loop embedded in the anterior part of the acrylic on the cleft

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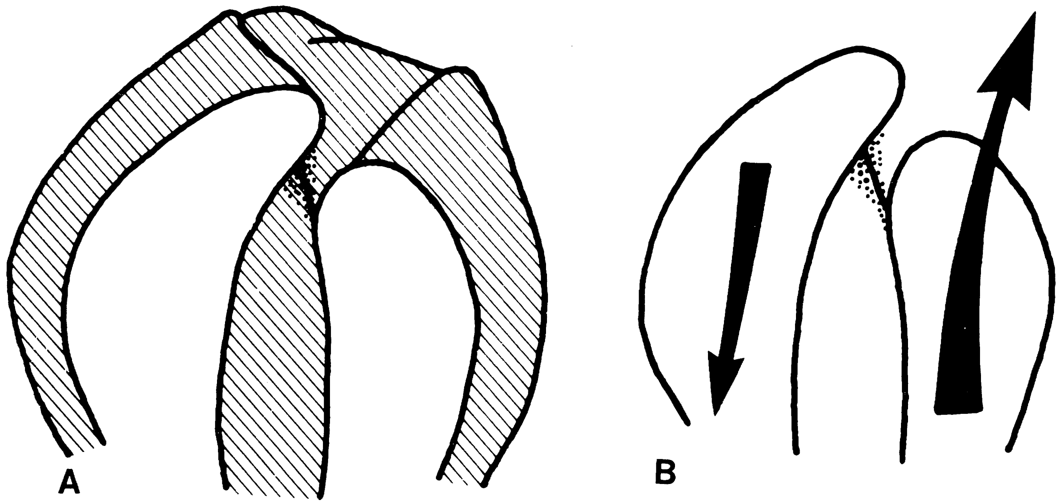

FIGURE 1. (A, left). Drawing of palatal cast of two-month-old infant to show anteroposterior discrepancy of dentoalveolar arch alignment for which there was a corresponding depression of the alar base. (B, right). Arrows indicate the desired force vectors for cleft maxillary advance and some retraction of the noncleft segment.

side. Clockwise turns of the screw moved the cleft side of the appliance towards the screw head. The position of the screw in relationship to the noncleft side remained the same (Figure 2).

The sites of insertion of the pins in the medial part of the palatal segment were predetermined during the construction of the appliance and marked on the plaster cast. The angle of insertion was 30°–40° from the vertical so as to penetrate palatal bone and yet remain clear of developing teeth (Figure 3). Holes were drilled in the plaster cast only deep enough to receive the wire part of the slot formers (Figure 4). The slots produced by these formers in the acrylic polymer bases exactly accommodated the double bent head of the pins with a little compression. Thus, at insertion, the pins locked into the slots in the appliance.

It appeared that anchorage on the noncleft segment would cause some retraction of the premaxillary alveolar segment, and this was thought to be a good feature of the design (Figure 2). An anatomical analysis suggested that sufficient advance of the cleft maxillary segment might be achieved before an undesirable amount of premaxillary retrusion occurred. The cleft segment appeared to have greater freedom to move anteriorly than the noncleft segment had to move posteriorly. Furthermore, orthopedic displacement of the cleft maxilla anteriorly would be in the same general direction as normal maxillary growth. On the other hand, retraction of the premaxillary segment would require a posterior displacement of the entire noncleft maxillary segment. This would be resisted by the presence of retro-maxillary fatty tissue, muscles, and adjacent bones, as well as by the quite extensive additional attachment of the noncleft maxilla to the vomer and nasal septum. After the removal of the appliance, these same factors would also act to reverse undesirable posterior displacement.

Appliance Insertion.

The appliance insertion was carried out in the hospital dental clinic. The infant was sedated with a mixture of Demerol, Largactil, and Phenergan given intramuscularly. The head of the screw in the appliance was visible in the cleft at lip level and was readily turned using a small screwdriver (Figure 5). A schedule of one turn daily was satisfactory in the younger infants. In a 23-week-old baby, it was turned once on alternate days.

Measurement.

Measurements of the anteroposterior malalignment of the dento-alveolar ridge were made on record casts obtained in the week prior to appliance insertion. The same dimension was again measured on the casts obtained

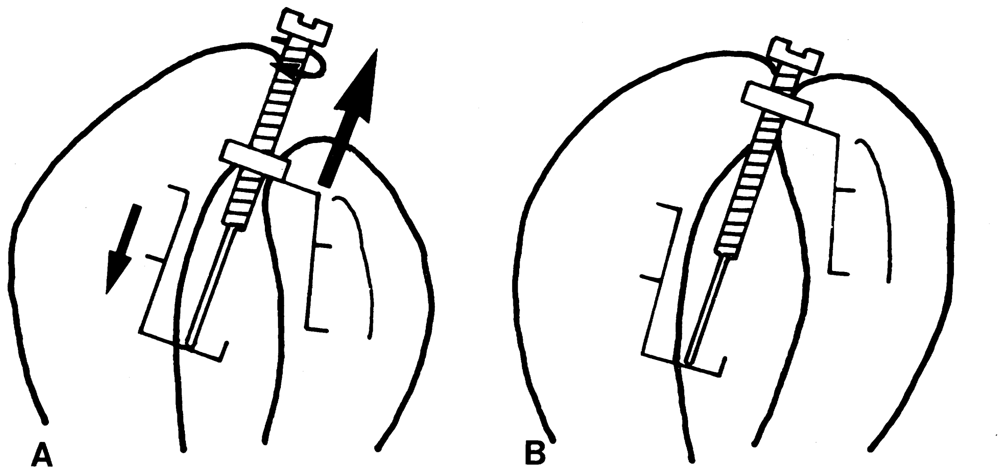

FIGURE 2. Diagram showing appliance design. (A, left). Anteroposteriorly mounted screw with end dethreaded to permit free turning when recessed into acrylic base of noncleft side. Pinned acrylic base on cleft side is attached to screw by wire loop so that advance of threaded nut will also advance appliance base. (B, right). With the turning of the screw and the movement anteriorly of the threaded nut, the appliance base on the cleft side moves to align with the noncleft side. Position of the screw remains unchanged in relationship to the noncleft segment.

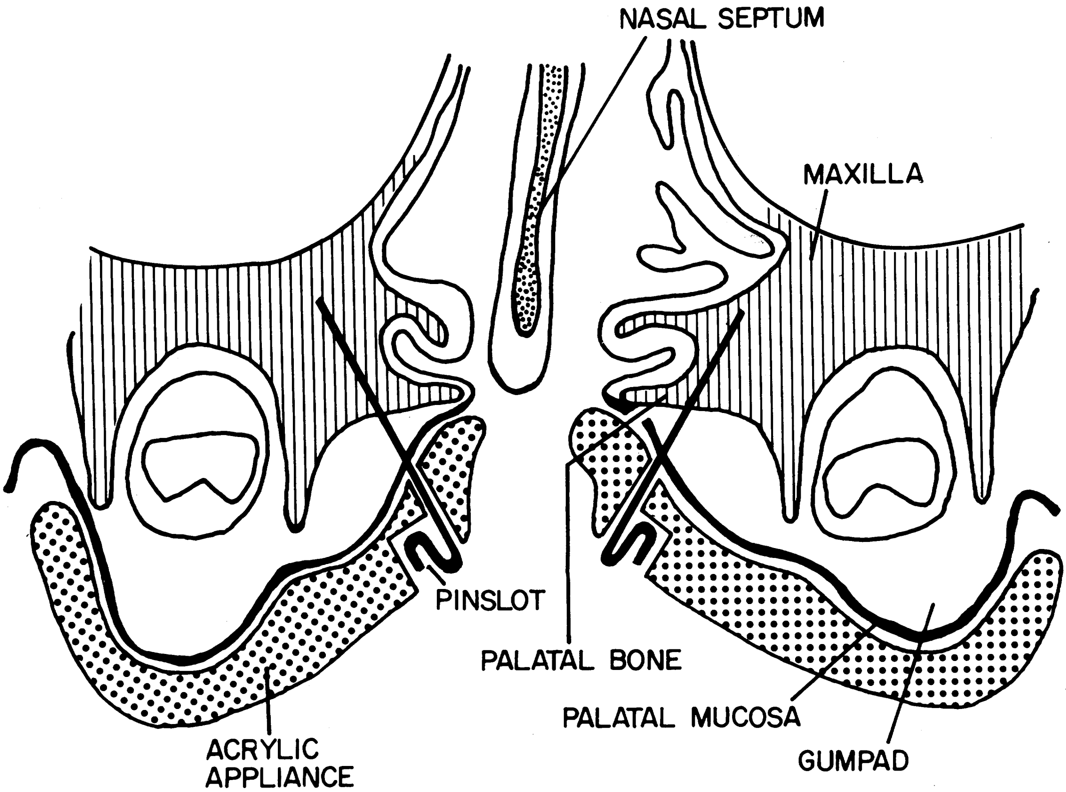

FIGURE 3. Diagrammatic representation of a coronal section through a cleft palate to show the site and path of the insertion of pins in relationship to surface structural features and developing teeth.

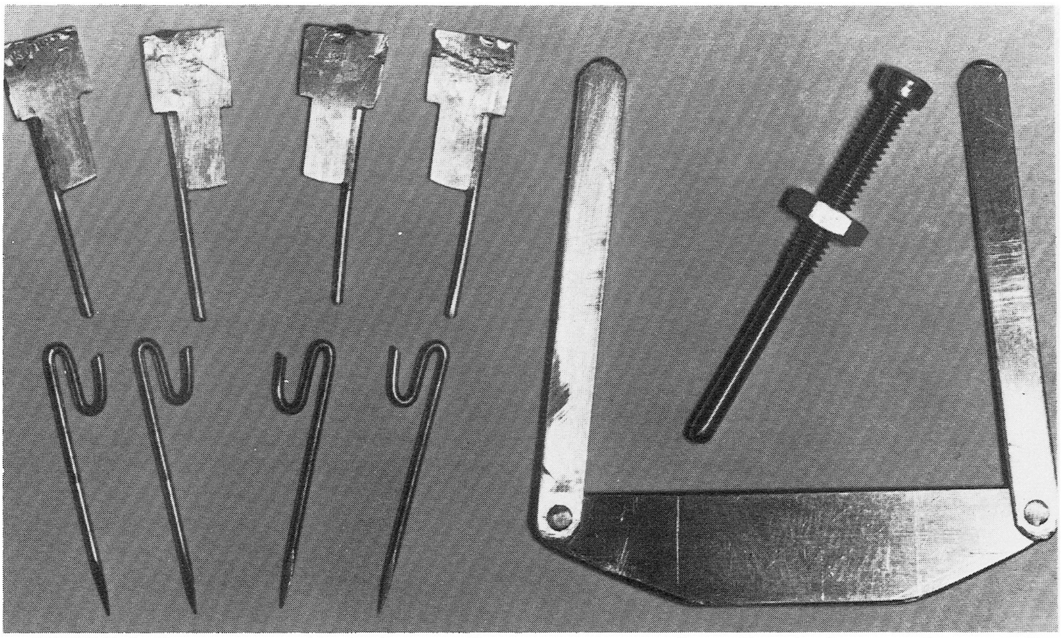

FIGURE 4. Components used in the dentomaxillary advancement appliance. Four slot formers and corresponding stainless steel pins (left). The segment arm and crossbar component maintains the stability of the pin retention angle. The stainless steel screw is partly dethreaded and retains a nut on the threaded part.

FIGURE 5. Dentomaxillary advancement appliance shown after insertion in patient S.W. Retention pins are visible in the pin slots in the acrylic polymer bases. Note convenience of screw head in cleft at lip level for activation.

on the same day as appliance removal. The measurement was made from the crest of the gingival ridge on the anterior border of the cleft maxillary segment to the ridge crest at the cleft premaxillary border.

Results

A distinct change was observed in the position of the cleft maxillary segments. Better alignment of the dento-alveolar ridge could be seen and was confirmed on palatal casts obtained after appliance removal (Figures 6 and 7). The reduction in the anteroposterior discrepancy between the cleft and noncleft dental ridges in three patients was as follows: E. W., 3.5 mm (in 13 days); T. B., 5.21 mm (in 9 days); and S. W., 4.25 mm (in 20 days). In patient E. W., movement was resisted by

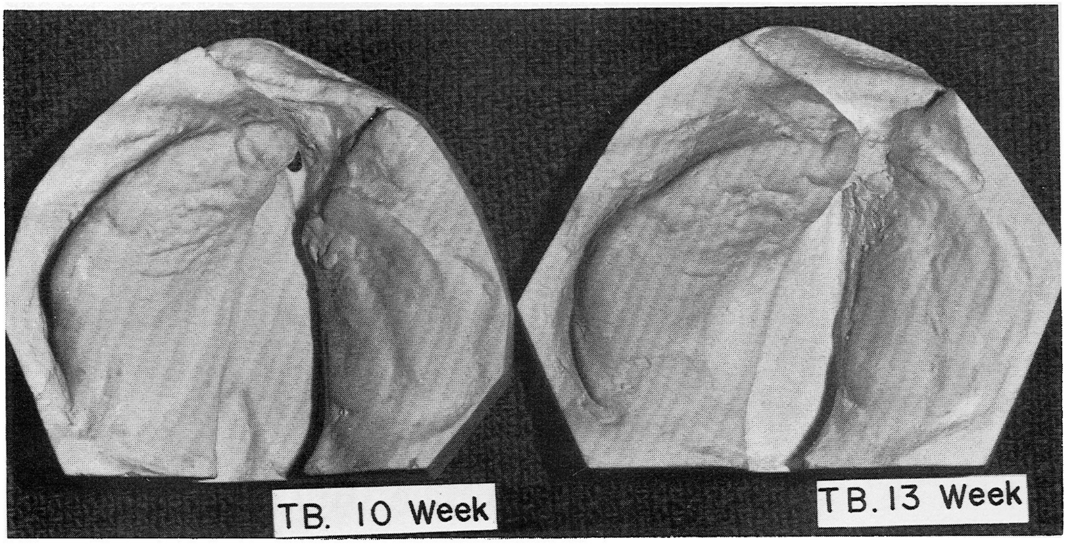

FIGURE 6. Palatal casts of patient T.B. before appliance insertion at age 10 weeks and on the day of removal at age 13 weeks. Note change in relationship of cleft alveolar segments.

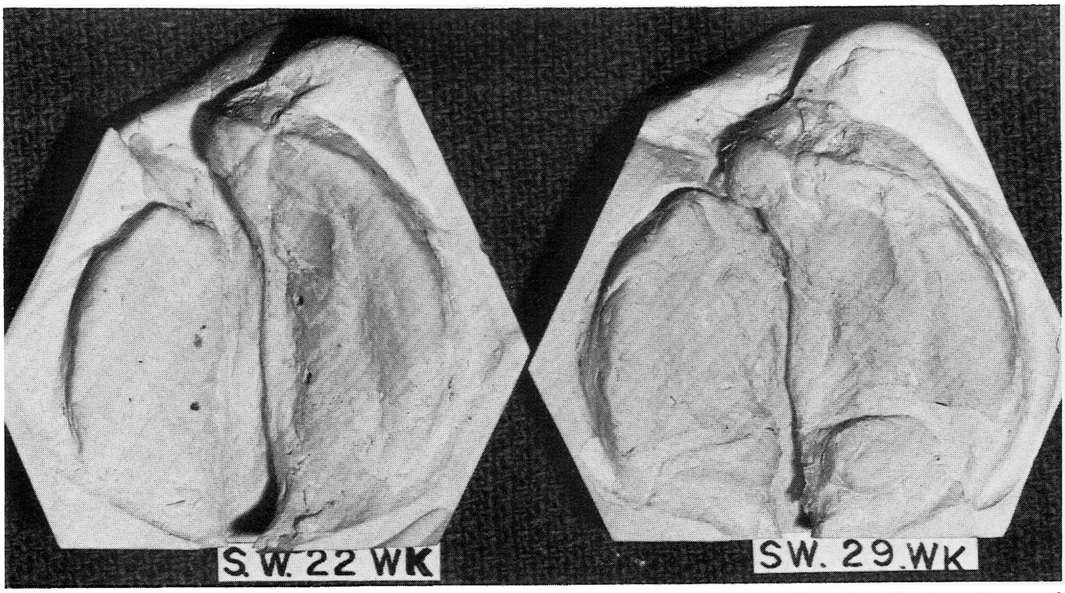

FIGURE 7. Palatal casts of patients S.W. before appliance insertion at age 22 weeks and on the day of removal at age 29 weeks. Note change in arch form at cleft alveolar edges.

a tissue connection across the alveolar cleft. The younger patients (two months old) appeared to accommodate to appliance activation much more readily than did S. W., who was five months old.

Improvement in anteroposterior symmetry of the alar bases as determined from photographic records was apparent in all infants (Figures 8 and 9). A retention period of at least 10 days was allowed after which the appliance was removed, about one week before surgery. Relapse was not clinically apparent either at the time of surgery or three weeks after surgery except in the case of S.W., in whom a relapse of 1.17 mm had occurred in the previous maxillary advancement of 4.25 mm.

Discussion

McNeil (1950, 1954) demonstrated that some control of the dento-alveolar arch in the cleft infant was possible using a removable intra-oral plate. Subsequently Burston (1958) regarded the stimulation of forward growth of the maxillary segments as an important function of the method. Two basic processes of normal maxillary growth appear to be involved in the response to a forward traction on the maxilla. They are the adjustment of collagen fibers in the sutures holding the bones together and growth at the back of the maxilla. Accordingly, two questions arise with regard to stability. First, could rapid movement of the maxilla cause tensions in sutural fibrous tissue that would bring about relapse later? The assumption is that the sutures would rapidly accommodate to a new maxillary position and would subsequently tend to preserve it. On the other hand, extensive maxillary movement would put a stress on facial soft tissue integument and muscles that would cause some relapse. However, in total bone

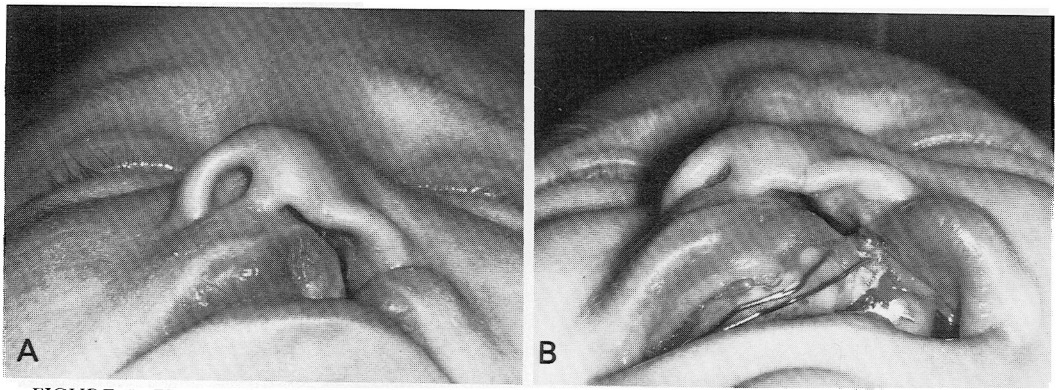

FIGURE 8. Photographs of the nose from inferior viewpoint of patient T.B. (A, left). At age 10 weeks before appliance insertion showing depressed alar base on cleft side. (B, right). 10 days later showing alar bases at much the same level as a result of appliance activation completed the previous day.

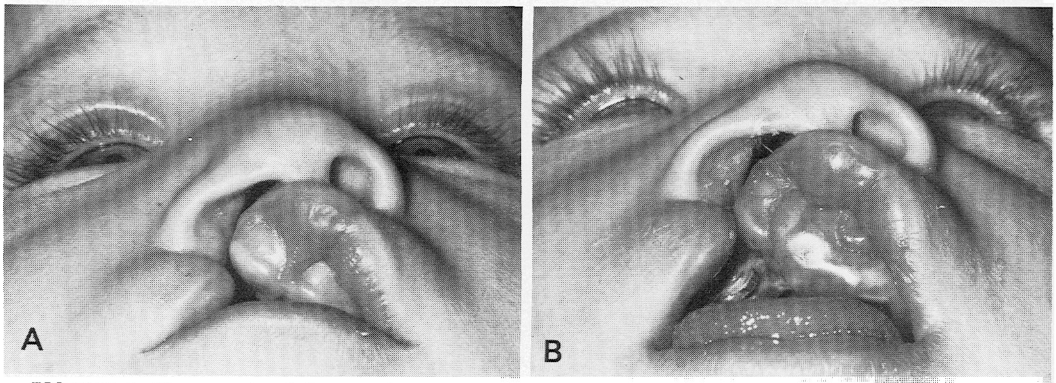

FIGURE 9. Photographs of the nose from inferior viewpoint of patient S.W. (A, left). At age 22 weeks before appliance insertion showing depressed alar base on cleft side. (B, right). At age 29 weeks, immediately before appliance removal, showing less relative depression of cleft alar base.

movement within reasonable limits, much of the soft tissue is also obliged to move because of attachment to the bone. These soft tissues may be as much in equilibrium in the new position as in the old. Second, would a rapid forward movement of the maxilla tend to increase the rate of osteogenesis on the posterior surface of the maxilla? Either one of two theories of maxillary growth apply. First, according to the maxillary compensatory growth view (Scott, 1954; Moss, 1962) a forward orthopedic displacement of the maxilla that developed a tension between the bone and adjacent tissues would stimulate maxillary osteogenesis until a passive state of the periosteal tissues was restored. Second, according to an intrinsic maxillary growth view (Latham, 1968; Latham and Scott, 1970), it is postulated that the retromaxillary periosteum encapsulates a pressure-exerting process of osteogenesis that is firmly supported posteriorly by fatty tissue, muscles, and skeletal structures and that this growth pressure is normally relieved by a forward displacement of the maxilla. In this circumstance, an orthopedic advancement of the maxilla might result in accelerated posterior osteogenesis until the normal pressure level was restored. In both cases, the expectation would be that the maxilla would grow to accommodate to the new position and that the newly added bone would be in place to resist relapse.

Three aspects of the present results, namely the change in alar base position, the alignment brought about in the alveolar arch, and the rapidity with which these occured, suggested that the appliance did apply a forward force to the cleft maxilla, which responded by a forward movement. It appears that the maxillary sutures may have provided the expected adjustment, a sliding of the maxilla in relationship to the zygomatic and palatine bones. The permanent benefits of using the present dentomaxillary advancement appliance cannot yet be assessed. It is necessary to enlarge the sample under study and to follow the children longitudinally and in comparison with children not so treated.

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References

BERKELEY, W. T., Correction of the unilateral cleft lip nasal deformity, in Grabb, W. C., Rosenstein, S. W., and Bzoch, K. R., *Cleft Lip and Palate.* Boston: Little Brown and Co., 227, 1971.

BURSTON, W. R., The early orthodontic treatment of cleft palate conditions, Trans. B.S.S.O., *Dent. Practit.*, *9*, 41–56, 1958.

GEORGIADE, N. G., The management of premaxillary and maxillary segments in the newborn cleft patient, *Cleft Palate J.*, *7*, 411–418, 1970.

LATHAM, R. A., A new concept of the early maxillary growth mechanism, *Trans. Europ. Orthod. Soc.*, 53–63, 1968.

LATHAM, R. A., Developmental deficiencies of the vertical and anteroposterior dimensions in the unilateral cleft lip and palate deformity, in Georgiade, N. G., Ed., *Symposium On Management of Cleft Lip And Palate And Associated Deformities.* St. Louis: C. V. Mosby Co., 10–12, 1974.

LANTHAM, R. A., and SCOTT, J. H., A newly postulated factor in the early growth of the human middle face and the theory of multiple assurance, *Arch. Oral Biol.*, *15*, 1097–1100, 1970.

MCNEIL, C. K., Orthodontic procedures in the treatment of congenital cleft palate, *Dent. Record*, *70*, 126–132, 1950.

MCNEIL, C. K., *Oral and Facial Deformity.* London: Pitman, 1954.

MILLARD, D. R., Preservation of natural landmarks in unilateral cleft lip, *J. Amer. Med. Ass.*, *169*, 133–134, 1959.

MILLARD, D. R., *Cleft Craft, Vol. 1, The Unilateral Deformity.* Boston: Little, Brown and Co., 21, 1976.

MOSS, M. L., The functional matrix, in Kraus, B. S., and Reidel, R. A., Eds., *Vistas In Orthodontics.* Philadelphia: Lea and Febiger, 1962.

SCOTT, J. H., The growth of the human face, *Proc. Roy. Soc. Med.*, *47*, 91–100, 1954.