Review Article

Maxillary orthopedics in the presurgical management of infants with cleft lip and palate

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The use of maxillary orthopedic appliances to treat infants with cleft lip and palate has been a subject of debate for many years. Much controversy lies in the type and timing of orthopedic intervention and in the timing of surgery. Infants with wide unilateral cleft lip and palate (UCLP) or bilateral cleft lip and palate (BCLP) with a protrusive premaxilla are particularly problematic for the surgeon due to the distance the tissue must be mobilized to close the defect. Surgical closure of a wide defect causes excessive tension on the suture line, which may lead to failure. It is common to use a two-stage cheiloplasty in many of these circumstances. The objective of the first stage, lip-adhesion surgery, is to attach the orbicularis oris muscle and allow muscle forces to mold the maxillary segments, thus facilitating the definitive lip repair.[1] In most patients with cleft lip and palate (CLP), arch alignment without the use of active and/or passive appliances is often unfavorable. Coordination between the plastic surgeon and the dentist has made it possible to better position the maxillary segments in order to facilitate a one-time surgical repair of the lip.

Proper repair of the CLP can produce favorable changes in the initial distortion seen in infants with a cleft.[2] Crossbite of the dentition in the child with CLP is a common clinical finding.[3] Undoubtedly, a predisposition to dental crossbite is established early in infancy, either as a result of the birth defect or as an unfavorable response of the alveolar segments to the influence of lip and palate repair. This has led some authors to recommend the use of presurgical orthopedics in an attempt to control arch form in the early years surrounding most major surgical repairs.[4–8] With a balanced, stabilized maxillary platform, a definitive cheiloplasty and/or rhinoplasty may be more ideally completed. Presurgical infant orthopedics achieve alignment of the maxillary segments, presenting a more symmetrical platform and width reduction of the alveolar ridge cleft. This enables elevation of the alar base on the cleft side and lip closure without tension or with minimal tension.[8]

Passive acrylic appliances may be utilized for molding and/or retention. If the lateral segments are held in position by a maxillary appliance, the premaxillary segment responds to the muscle forces of the lip—resulting in lingual movement, probably through reshaping of the vomer and nasal septum. Hochban and Austermann[9] treated 20 infants with UCLP with passive appliances until the hard palate and alveolus were repaired at approximately age 3 years. Collapse of the alveolar segments was evident after appliance therapy was discontinued. In cases of BCLP with adequate transverse width, a removable palatal appliance to maintain the position of the lateral segments—with an acrylic bulb fitted over the premaxilla for retraction—may be used. Anchorage for the premaxillary retraction may be achieved by extraoral straps attached to a bonnet worn by the infant.[10] In a study of 40 children with BCLP, each subject was assigned to a group, which 1) received orthopedic therapy with intraoral appliances and a bonnet with extraoral straps or 2) received same treatment without orthopedic forces.[11] Records were taken during primary and mixed dentition stages. Significantly greater incidences of incisor crossbite were reported in the untreated cases in both primary and mixed dentitions. In terms of maxillary anteroposterior displacement, the effect of passive appliances in treating infants with CLP must be regarded as unpredictable.[12]

The aims of this article are to review presurgical maxillary orthopedic techniques and the advantages and disadvantages of appliance therapy, and to illustrate fixed appliance therapy in infants with unilateral and bilateral cleft lip and palate.

Purpose of appliance therapy

The objectives of early active maxillary orthopedics are two-fold. First, in cases of wide unilateral clefts (Fig 1) or protrusive premaxilla in bilateral clefts (Fig 2), the initial cheiloplasty is difficult due to the distance the tissue must be mobilized to close the defect. This causes excessive tension on the surgical site, which may lead to wound dehiscence. Presurgical maxillary orthopedics allow earlier, more ideal lip closure with minimum tissue tension since the soft tissues will overlie a more normal bony anatomy. If definitive closure of the de-

Fig 1. UCLP, occlusal view

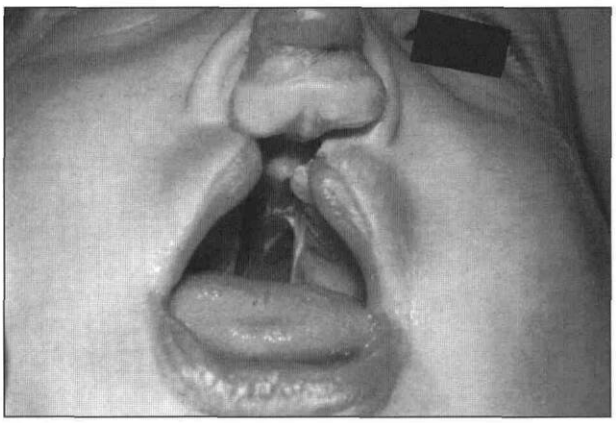

Fig 2. BCLP, occlusal view

fect will cause excessive tension on the surgical site, the surgeon also may elect to perform the lip repair in two stages. By using orthopedic therapy, the requirement of lip adhesion surgery prior to a definitive repair may be eliminated. Early maxillary orthopedics can move the maxillary segments to a more anatomically correct position and the soft tissues will be carried with the segments, leading to a decrease in the width of the defect, which will reduce surgeon time, hospital time, and the risks of additional general anesthesia. Eliminating lip adhesion surgery also eliminates the need to perform additional surgery in the presence of scar tissue from an earlier operation. Additionally, if lip closure is accomplished in one operation, the patient has a more normal appearance earlier in life, and the risk and cost of an additional surgical procedure are eliminated.

Second, left untreated, the lateral alveolar segment(s) usually "collapse", leading to malalignment as depicted in Fig 3. With early orthopedic intervention, a more normal arch form may be achieved, resulting in better alignment of the segment(s) as in Fig 4. The more normal or near normal alveolar alignment leads to better soft tissue approximation. It is unknown whether this arch alignment will lead to more ideal occlusal relationships with future growth. Long term, well-controlled studies are necessary to determine the effect of early orthopedic therapy on final growth.

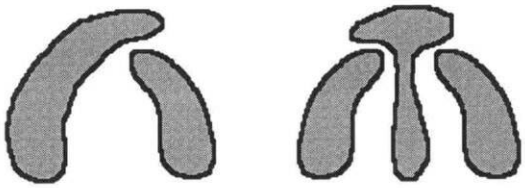

Fig 3. UCLP-collapsed alveolar segments *(left)*. BCLP-collapsed lateral segments with a protrusive premaxilla *(right)*

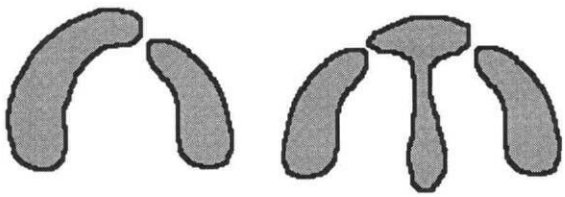

Fig 4. UCLP-ideal alignment *(left)*. BCLP-ideal alignment *(right)*

Unilateral cleft lip and palate

Appliance design and mechanics

The fabrication of any intraoral appliance depends on an accurate impression. Tempered red compound impression material is recommended because it is less likely to flow deep into undercuts of the cleft. Breakage of impression material in the cleft may result in difficult retrieval and/or airway obstruction. During the impression procedure it is recommended that the infant be placed prone, which displaces the tongue downward and forward, promoting a patent airway and avoiding aspiration if vomiting occurs. The stone model produced from the impression is used to fabricate the orthopedic appliances.

The appliances used in the orthopedic treatment of infants with UCLP can be divided into two major categories: removable and fixed. Both appliances generally consist of acrylic pads adapted to the alveolar segments and an adjustment screw, which induces movement of the segments. The lack of retention of the removable appliance limits its use as an active presurgical appliance. The fixed appliance, which is attached to the palatal bone by stainless steel pins, provides good retention and a constant, controllable orthopedic force. An example of this type appliance is the dentomaxillary advancement (DMA) appliance described by Latham[13] (Fig 5). It has been advocated that an ideal approach to treatment of infants with UCLP would be to move the entire maxilla forward using traction to stimulate an adjustment response of the maxillary sutures.[13] Such an advancement would improve alignment of the dental arch. If this were accomplished prior to surgery, the cheiloplasty might result in more normal anatomic relationships with minimal mobilization of facial tissues. The DMA appliance was developed for such an orthopedic correction.

The DMA appliance has two acrylic pads joined by a posterior stainless steel hinged strut. The end of the adjustment screw, which is attached to the lesser segment, fits into a slot on the greater segment. The appliance is attached to the palatal bone using stainless steel pins placed 30–40° to the vertical. This pin placement facilitates good retention and avoids the developing teeth. Rotation of the screw applies a force that advances the lesser segment anteriorly (Fig 6). The greater segment acts as anchorage, but does receive slight posterior rotation of the premaxillary position.

Appliance placement, activation, and removal

Once constructed, the appliance is evaluated to ascertain proper fit, correct advancement of the threaded screw, tongue clearance, and freedom from possible areas of tissue irritation. The infant is sedated with proper monitoring and local anesthesia is infiltrated into the palate in the areas of pin placement. The appliance is placed on the palate and the retaining pins are inserted at the proper orientation and seated. Cold-cure acrylic may be placed over the pins. Parents are given postoperative instructions and the correct method of daily appliance activation. The patient is followed weekly, and surgery is scheduled for lip closure when the segments are approximated. Depending on the width of the cleft, 2 to 3 weeks of daily activation is required. The appliance is removed in the operating room at the time of the cheiloplasty. With appropriate alignment of the alveolar segments, elevation of the alar base and definitive lip repair with excellent esthetics (Fig 7) can be achieved.

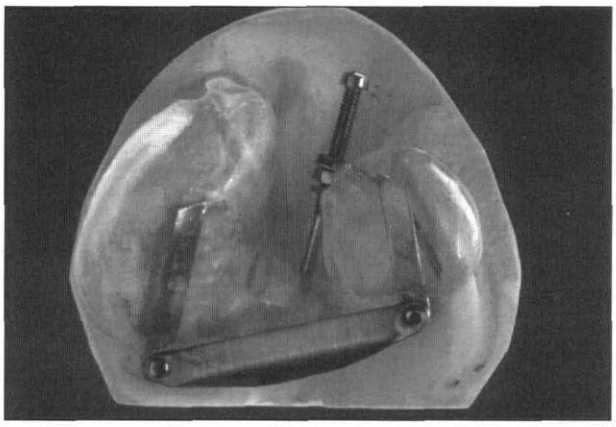

Fig 5. DMA appliance

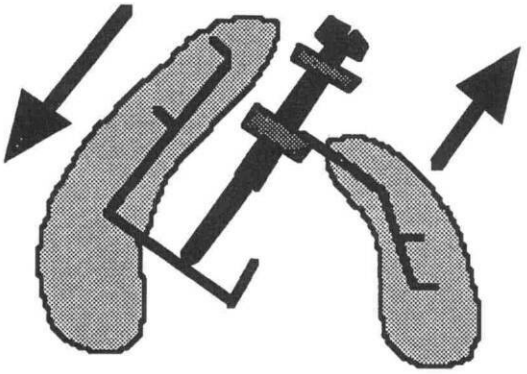

Fig 6. DMA appliance mechanics

Bilateral cleft lip and palate

Appliance design and mechanics

The orthopedic appliances used to treat infants with BCLP may be divided into removable, fixed, and combination appliances. Many patients with BCLP benefit from premaxilla retraction. If the lateral segments are not collapsed medially, they can be maintained by using a lateral segment stabilization appliance (fixed or removable) while the premaxilla is retracted with extraoral strapping.[14] In cases where the lateral segments block the premaxilla retraction, an expansion appliance is necessary. The expansion appliance also may be removable or fixed. One must use caution in placing the retraction component of the appliance. If not precisely positioned, a downward rotation of the premaxilla may result, rather than retraction. Lack of retention with removable appliances may prohibit optimal results, while a pinned expansion appliance with an extraoral retraction strap is a treatment alternative.[15]

Georgiade and Latham[16] described an intraoral fixed appliance with a palatal expansion component and a pin placed into the premaxilla for premaxillary retraction. This totally intraoral, fixed appliance utilizes elastic chain premaxillary retraction (ECPR). The appliance consists of acrylic pads over the lateral segments connected posteriorly by an expansion mechanism (Fig 8). The premaxilla is retracted by elastic chains attached to a pin placed through the premaxilla just anterior to the premaxillovomeral suture.

Appliance placement, activation, and removal

Inserting the ECPR appliance requires more precision than the appliances used for orthopedic movement in UCLP, and it is best placed using general anesthesia. The location of the premaxilla pin is marked using radiographs (Fig 9) and anatomical landmarks. The pin is placed anterior to the premaxillovomeral suture by first preparing two parallel holes into the vomer. With

Fig 7. Following cheiloplasty

one elastic chain attached to the closed end of the pin, the pin is inserted through the vomer via the prepared holes. The second elastic chain is attached to the open end of the pin on the opposite side of the vomer. The open end of the pin is bent closed to secure the elastic chains. The acrylic pads are placed on the lateral segments and the palatal pins placed. The elastic chains are passed via a roller on the posterior of the palatal portion of the appliance and adjusted to approximately 3 oz of tension prior to attachment to the anterior of the palatal portion of the appliance.

Parents are given instructions for postoperative care and daily appliance activation. The patient is followed weekly and surgery is scheduled for lip closure when the premaxilla is retracted (Fig 10). Depending on the width of the cleft, 2 to 3 weeks of daily activation is required. The appliance is removed in the operating room at the time of the cheiloplasty. Retraction of the premaxilla facilitates definite lip repair with excellent results (Fig 11).

Facial morphology considerations

The reasons for abnormal facial morphology in children with a cleft involves three factors: intrinsic developmental deficiencies, functional distortions affecting the position and growth of both normal and abnormal parts, and iatrogenic factors introduced by treatment.[17] It has been stated that the primary objective of early orthopedics is not to facilitate surgery, but to take advantage of intrinsic developmental potentialities.[4] Studies have concluded that the long-term outcome on dentofacial morphology of the specific surgical management of the UCLP patient cannot be predicted.[18] It was determined that up to 50% of all patients may develop normal arch form with little or no additional intervention other than surgery itself. An equal number will suffer immediate postsurgical arch collapse that does not improve.

Changes caused by iatrogenic factors are of great concern. For example, it has been demonstrated that palatal tissue growth is retarded after orthopedic appliance therapy.[19] Despite this effect, presurgical orthopedic treatment should be considered since it facilitates lip and palate repair and has beneficial social aspects. The social perception of the cleft impairment is a complex process that includes the severity of the facial deformity and overall facial attractiveness.[20] These findings suggest that a surgical intervention that significantly reduces severity and improves esthetics should improve social desirability.

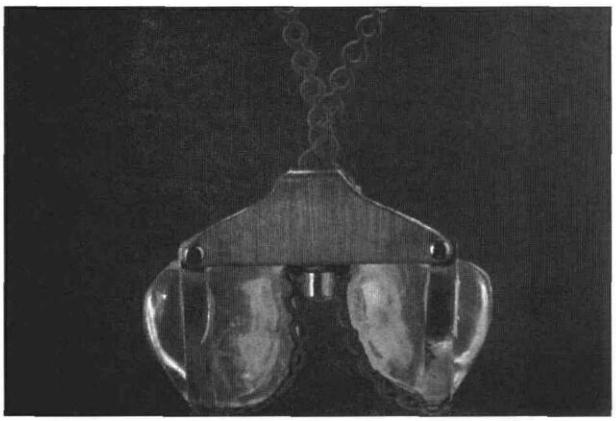

Fig 8. ECPR appliance.

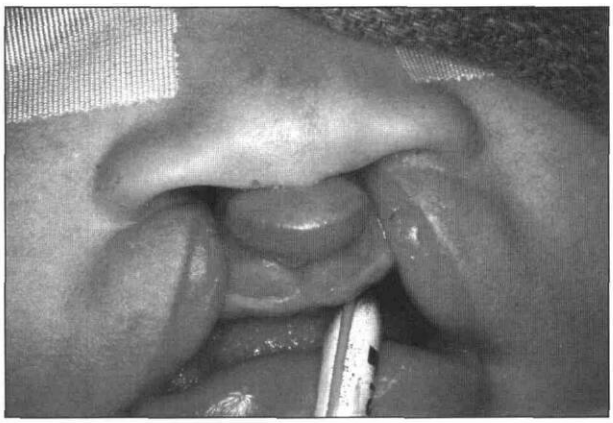

Fig 10. Post-ECPR therapy.

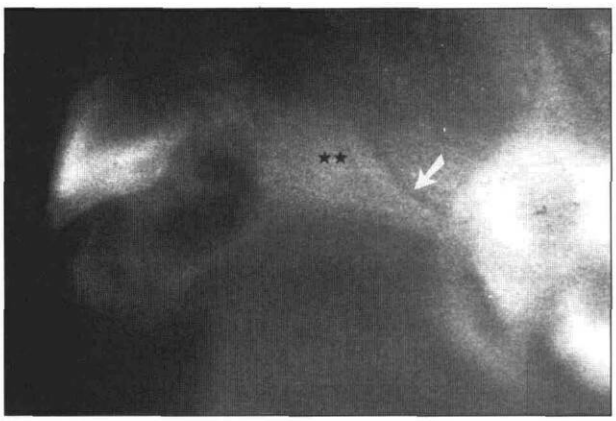

Fig 9. Lateral radiograph demonstrating premaxillovomeral suture (arrow) and placement of premaxillary pin (*)

Fig 11. Following cheiloplasty.

Family involvement

In studies of families of children with craniofacial anomalies, 91% of respondents of a survey indicated their desire to participate in treatment decisions; 36% wished for more participation.[21] Active orthopedics involves the family in the daily home care and appliance adjustment. Such participation gives parents satisfaction since they are actively involved in the treatment necessary to correct their infant's birth defect.

Success/retention debate

Beyond the orthopedic therapy questions, there is considerable debate on what type of surgery should be performed to maintain the orthopedic correction. Early autogenous bone grafting often is used to stabilize both passive and active orthopedic corrections.[22] A group of 35 children with BCLP, UCLP, or UCL and alveolus were followed from age 5 to 17 years.[23] Periosteoplasty was performed between age 4 and 7 years and resulted in bone formation in 80% of the cases, with new bone formation continuing for several years. When compared to controls with neither bone graft nor periosteoplasty, the delayed periostoplasty was suggested to be superior because there is no negative effect on the dental occlusion or craniofacial growth.

The period of puberty is important in the development of the face and in effecting the results of orthodontic therapy. Smahel and Mullerova[24] examined craniofacial growth and development in males with UCLP between the ages of 10 and 15 years who had primary osteoplasty at the time of lip repair. The data were compared to males with similar treatment, with the exception of periostoplasty at the time of lip repair rather than bone graft. Persistent anterior crossbite was more common in the individuals who had primary osteoplasty at the time of lip repair. It is very clear that the use of preoperative maxillofacial orthopedics and the timing and type of surgery requires an individual approach to each case.

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1. Van der Beek MCJ, Hoeksma JB, Prahl-Andersen B, Meijer R: Effects of lip adhesion and presurgical orthopedics on facial growth: an evaluation of four treatment protocals. J Biol Buccale 20:191–96, 1992.
2. Profitt WR, Turvey TA: Special problems in cleft palate patients. In: Profitt WR, White RP, Eds. Surgical orthodontic treatment. St Louis: CV Mosby Co: 625, 1990.
3. Cooper HK, Long RE Sr, Long RE Jr, Pepek JM: Orthodontics and oral orthopedics. In: Cleft Palate and Cleft Lip: A Team Approach to Clinical Management and Rehabiliation of the Patient. Cooper HK, Harding RL, Krogman WM, Mazaheri M, Millard RT, Eds. Philadelphia: WB Saunders Co, 1979, pp 358–429.
4. Hotz MM: Pre- and early post-operative growth guidance in cleft lip and palate cases by maxillary orthopedics: an alternative procedure to primary bone grafting. Cleft Palate J 7:368–72, 1969.
5. Huddart AG: Presurgical changes in unilateral cleft palate subjects. Cleft Palate J 16:147–57, 1979.
6. Troutman KC: Maxillary arch control in infants with unilateral clefts of the lip and palate. Am J Orthod 66:198–208, 1974.
7. Lubit EC: Cleft palate orthopedics: why, when, how. Am J Orthod 69:562–71, 1976.
8. Millard DR Jr, Latham RA: Improved primary surgical and dental treatment of clefts. Plast Reconstr Surg 86:856–71, 1990.
9. Hochban W, Austermann KH: Presurgical orthopaedic treatment using hard plates. J Craniomax Illofac Surg 17:2–4, 1989 (Suppl)
10. Jones JE, Lynch TR, Sadove AM: Three dimensional premaxillary orthopedic technique for improved position and symmetry prior to cheiloplasty in bilateral cleft lip and palate patients. Quintessence Int 3:229–31, 1985.
11. Peat JH: Effects of presurgical oral orthopedics on bilateral complete clefts of the lip and palate. Cleft Palate J 19:100–3, 1983.
12. Sarnäs KV, Rune B, Selvik G, Jacobsson S: Maxillary development in six unilateral cleft lip and palate children treated with passive orthopaedic plates. Eur J Orthod 10:128–36, 1988.
13. Latham RA: Orthopedic advancement of the cleft maxillary segment: a preliminary report. Cleft Palate J 17:227–33, 1980.
14. Larson M, Sällström KO, Larson O, McWilliam J, Ideberg M: Morphologic effect of preoperative maxillofacial orthopedics (T-traction) on the maxilla in unilateral cleft lip and palate patients. Cleft Palate Craniofac J 30:29–34, 1993.
15. Latham RA, Kusy RP, Georgiade NG: An extraorally activated expansion appliance for cleft palate infants. Cleft Palate J 13:253–61, 1976.
16. Georgiade NG, Latham RA: Maxillary arch alignment in the bilateral cleft lip and palate infant, using the pinned coaxial screw appliance. Plast Reconstr Surg 56:52–60, 1975.
17. Ross RB: Treatment variables affecting facial growth in complete unilateral cleft lip and palate. Cleft Palate J 24:5–77, 1987.
18. Mazaheri M, Athanasiou AE, Long RE Jr, Kolokitha OG: Evaluation of maxillary dental arch form in unilateral clefts of lip, alveolus, and palate from one month to four years. Cleft Palate Craniofac J 30:90–93, 1993.
19. Huddart AG, Crabb JJ: The effect of presurgical treatment on palatal tissue area in unilateral cleft lip and palate subjects. Br J Orthod 4:181–85, 1977.
20. Tobiasen JM, Hiebert JM: Combined effects of severity of cleft impairment and facial attractiveness on social perception: an experimental study. Cleft Palate Craniofac J 30:82–86, 1993.
21. Pannbacker M Scheuerle J: Parents' attitudes toward family involvement in cleft palate treatment. Cleft Palate Craniofac J 30:87–89, 1993.
22. Jacobson BN, Rosenstein SW: Early maxillary orthopedics for the newborn cleft lip and palate patient. An impression and an appliance. Angle Orthod 54:247–63, 1984.
23. Hellquist R, Svärdström K, Pontén B: A longitudinal study of delayed periosteoplasty to the cleft alveolus. Cleft Palate J 20:277–88, 1983.
24. Smahel Z, Müllerová Z: Facial growth and development in unilateral cleft lip and palate during the period of puberty: comparison of the development after periosteoplasty and after primary bone grafting. Cleft Palate Craniofac J 31:106–15, 1994.