Orthodontic management of patients with cleft lip and palate

Pradip R. Shetye

Department of Plastic Surgery, New York University Langone Medical Center, New York, NY 10016, USA

Abstract

The management of patients with cleft lip and cleft palate requires prolonged orthodontic and surgical treatment and an interdisciplinary approach in providing them with optimal esthetics, function, and stability. This paper describes an update on the current concepts and principles in the treatment of patients with cleft lip and palate. Sequencing and timing of orthodontic/orthopedic and surgical treatment in infancy, early mixed dentition, early permanent dentition, and after the completion of facial growth will be discussed.

Key words: Cleft lip and palate, nasoalveolar molding, secondary alveolar bone graft

INTRODUCTION

Cleft lip and palate is the most frequently occurring congenital anomaly. Depending on the extent of the cleft defect, patients may have complex problems dealing with facial appearance, feeding, airway, hearing, and speech. Patients with cleft lip and palate are ideally treated in a multidisciplinary team setting involving specialties from the following disciplines: Pediatrics, plastic and reconstructive surgery, maxillofacial surgery, otolaryngology, orthodontics, genetics, social work, nursing, speech therapy, pediatric dentistry, prosthetic dentistry, and psychology. The orthodontic and surgical treatment of patients with clefts is extensive, initiating at birth and continuing into adulthood when craniofacial skeletal growth is finished. The role of the orthodontist in timing and sequence of treatment is important in terms of overall team management. The goal for the complete rehabilitation of patients with clefts is to maximize treatment outcome with minimal interventions.

In a patient with cleft lip and palate, the orthodontic malocclusion can be related to soft tissue, skeletal or dental defects. Some cleft orthodontic problems are directly related to the cleft deformity itself, such as discontinuity of the alveolar process, and missing or malformed teeth, whereas other aspects of the malocclusion are secondary to the surgical intervention performed to repair the lip, nose, alveolar and palatal defects. A malocclusion may exist in all the three planes of space: Anteroposterior, transverse, and vertical. The malocclusion may reflect the severity of the initial cleft deformity and the growth response to the primary surgery. As malocclusion in patients with clefts is often a growth-related problem, the effect of the cleft deformity and primary surgery will be observed throughout the growth of the child until skeletal maturity. The orthodontist must make critical decisions for orthodontic intervention at the appropriate time and prioritize treatment goals for each intervention. For the

Access this article online	
Quick Response Code:	Website: www.apospublications.com
	DOI: 10.4103/2321-1407.194790

Address for Correspondence:
Asst. Prof. Pradip R. Shetye, Department of Plastic Surgery, New York University Langone Medical Center, 307 East 33rd Street, New York, NY 10016, USA.
E-mail: pradip.shetye@nyumc.org

How to cite this article: Shetye PR. Orthodontic management of patients with cleft lip and palate. APOS Trends Orthod 2016;6:281-6.

purpose of the organization, the orthodontic treatment of patients with clefts will be presented in four distinct treatment phases: Infancy, primary dentition, mixed dentition, and permanent dentition.

TREATMENT DURING INFANCY

Presurgical infant orthopedics has been used in the treatment of cleft lip and palate patients for centuries. In 1993, Grayson *et al.* described a new technique, nasoalveolar molding (NAM), to presurgically mold the alveolus, lip, and nose in infants born with cleft lip and palate.[1]

The initial impression of the infant with cleft lip and palate is obtained within the 1st week after birth using a heavy body silicon impression material, and the NAM appliance is inserted within the first 2 weeks. The NAM appliance has two components—the oral (molding plate) and the nasal (nasal stents). The oral component molds the clefted alveoli in order to allow them to approximate each other. The nasal components mold the distorted nasal cartilage on the clefted nose, making it more symmetrical [Figure 1]. Nasal molding helps expand the tissue of the mucosal lining of the nose. In unilateral cleft patients, the nasal stent straightens the deviated columella toward the noncleft side. In patients with bilateral cleft lip and palate, the nasal stent elongates the deficient columella by gradually stretching the columella tissue. With the help of tape, the lips also are molded to reduce the size of the cleft. This process is done over a 3–4-month period and with active involvement by the family in the NAM process. A recent study of caregivers demonstrated that NAM was often associated with positive factors for parents such as increased empowerment, self-esteem, and bonding with their infant.[2] After completion of NAM treatment, the infant is then referred to the surgeon for primary closure of lip, nose, and alveolus.

There are several benefits with the NAM technique in the treatment of cleft lip and palate deformity. Proper alignment of the alveolus, lip, and nose helps the surgeon achieve a better and more predictable surgical result.[3] Long-term studies of NAM therapy indicate that the change in nasal shape is stable.[4] The improved quality of primary surgical repair reduces the number of surgical revisions, oronasal fistulas, and secondary nasal and labial deformities.[4-8] If the alveolar segments are in the correct position and a gingivoperiosteoplasty is performed, the resulting bone bridge across the former cleft site improves the conditions for the eruption of the permanent teeth and provides them with better periodontal support. Studies have also demonstrated that 60% of patients who underwent NAM and gingivoperiosteoplasty did not require secondary bone grafting[9] [Figure 2]. The remaining 40% who did need bone grafts showed more bone remaining in the graft site compared to patients who had not had gingivoperiosteoplasty.[10]

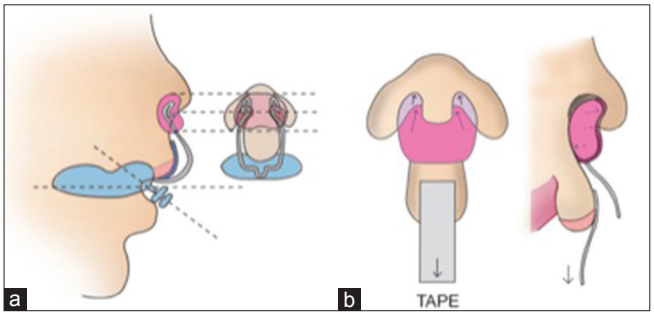

Figure 1: (a) Bilateral nasoalveolar molding plate with the nasal stents in placed (b) In a patient with bilateral cleft, a prolabial tape adhered to the prolabium and attached to the molding plate with tension

TREATMENT DURING THE PRIMARY DENTITION

The treatment goals during the primary dentition stage of development focus on the acquisition of normal speech function, which is managed by a speech therapist or pathologist and the surgeon. During this phase, the patient is closely monitored by the speech and language therapists. Patients may or may not need speech therapy depending on the diagnosis of speech issues. If the child has been diagnosed with velopharyngeal insufficiency, then the surgeon may perform a pharyngeal flap. This surgery is typically performed around age 2.

Another important component of care for a patient during this time period includes routine follow-up with

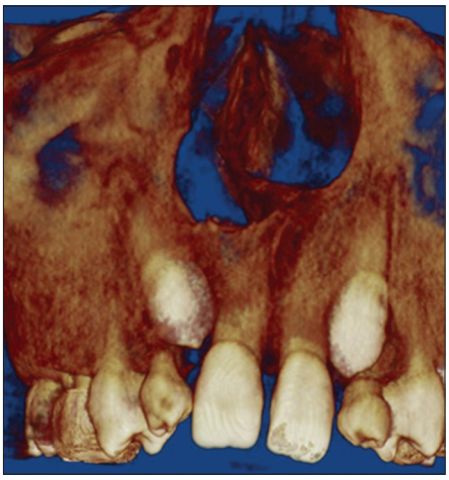

Figure 2: Sectional cone-beam computed tomography of a patient who underwent nasoalveolar molding and gingivoperiosteoplasty surgery to repair the alveolus at the time of primary lip closure. Note good bone formation on the right former cleft side. This patient did not need secondary alveolar bone graft surgery

a pediatric dentist. Regular visits to the pediatric dentist every 6 months are strongly recommended to prevent dental caries.

TREATMENT DURING MIXED DENTITION

The treatment objectives for a child as he/she enters mixed dentition are directed toward preparing the patient for secondary alveolar bone graft (SABG) surgery. The alveolar bone graft surgery is typically performed around 8–9 years of age. A limited volume cone-beam computed tomography (CBCT) performed at this age is invaluable to identify the cleft defect and the position of the permanent teeth adjoining the cleft defect. The principal benefits of alveolar bone grafting are: (1) To provide sufficient bone for the eruption of either the maxillary lateral incisor or canine, (2) to provide adequate bone and soft-tissue coverage around teeth adjacent to the cleft site, (3) to close the oronasal fistulae to prevent nasal air escape and fluid or food leakage, (4) to provide additional support and elevation to nasal structures, (5) to restore the alveolar ridge in the area of the cleft, thereby allowing orthodontic tooth movement and future placement of dental implants, and (6) to stabilize premaxillary segments in patients with bilateral clefts.

Discrepancies in maxillary arch form or transverse width should be improved before the SABG. It is of note that the surgeon and orthodontist must work in tandem to determine the anatomical limits of presurgical maxillary expansion. This is imperative, as overexpansion may create an oronasal fistula or a defect that is beyond the limits of surgical closure [Figure 3].

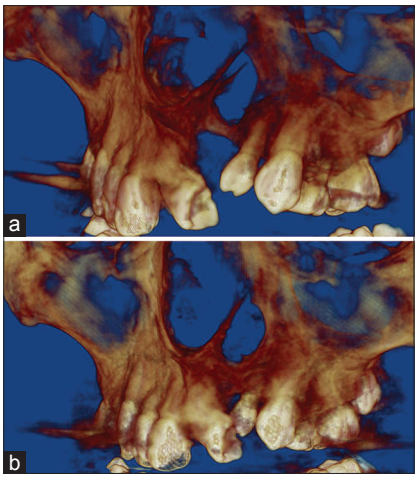

Figure 3: Sectional cone-beam computed tomography of pre- and post-alveolar bone graft sites. (a) Note the large alveolar defect on the lateral wall of the maxillary left central incisor. (b) The postalveolar bone graft sectional cone-beam computed tomography shows good bone formation of the alveolar cleft site 6 months postiliac bone graft

To provide the most stable environment for integration of the alveolar bone graft and the maintenance of palatal expansion, we routinely place an occlusally bonded acrylic or removable Tru-Tain type splint at the time of surgery. The splint serves to immobilize the alveolar segments as well as to prevent relapse of presurgical maxillary expansion. The splint remains in place for 6–8 weeks postsurgery.

The management of a bilateral cleft lip and palate patient may pose a unique challenge with respect to the position of the premaxilla before bilateral alveolar bone grafts. However, if the premaxilla is ectopically positioned, the patient may need premaxillary repositioning surgery. The presurgical expansion is preformed to improve the arch form before surgery. A bonded occlusal splint is constructed after model surgery. In the operating room, the surgeon uses the splint to reposition the premaxilla and perform the SABG surgery.

Six months after SABG surgery, a postoperative CBCT must be obtained to confirm the outcome of SABG surgery [Figure 4]. After successful repair of the cleft defect, the patient can then start Phase I fixed appliance treatment to correct malpositioned anterior teeth. If a patient shows a skeletal crossbite, manifested as negative overjet at this stage, protraction headgear treatment can be initiated for about 9 months to correct the skeletal crossbite.

TREATMENT DURING PERMANENT DENTITION

Lateral cephalometric growth studies have shown that the maxilla in treated patients with cleft lip and palate show

Figure 4: Occlusal (a) and frontal (b) views of a patient with bilateral cleft lip and palate who underwent rapid maxillary expansion with a bonded acrylic fan expander. Following transverse expansion, patient had bilateral alveolar bone grafts and premaxillary repositioning

variable degrees of maxillary hypoplasia. The reasons for abnormal facial morphology in treated cleft patients may involve intrinsic skeletal and soft tissue deficiencies, iatrogenic factors introduced by treatment, or a combination of both. At birth, cleft lip and palate deformities vary greatly in severity. In some patients, there may be adequate tissue volume, but the cleft segments have failed to fuse together due to inadequate cell migration. In others, there may be varying amounts of missing tissue (bone, soft tissue, and teeth) associated with nonfusion of the cleft segments. Both groups of patients may respond differently to surgical treatment.

Clinically, patients with clefts may present with a concave profile, midface deficiency, and a Class III skeletal pattern. The maxilla may also be deficient in transverse and vertical planes, contributing to posterior skeletal crossbite and reduced midface height. Dentally, there may be lingually inclined incisors and constricted maxillary posterior arch width, causing anterior or posterior crossbite. The extent of abnormal midface growth may vary from mild to severe. The severity distribution of abnormal midfacial growth is concentrated in the center of the bell curve, whereas patients with good growth and severe growth disturbances are dispersed on either side of the curve.[11] Depending on the severity of the malocclusion presented by the cleft patient, the management can be categorized into three types. In the first category, the patients have no skeletal discrepancy and orthodontic correction is limited to tooth movement only. In the second category, there is a mild skeletal discrepancy and the patients will benefit from camouflaging the malocclusion by orthodontic tooth movement alone. In the last category of patients, there is moderate to severe skeletal deformity, and optimal results can only be obtained by combined surgical/orthodontic intervention. It is important to establish as early as possible if the patient will be treated with orthodontics alone or orthodontics in conjunction with surgery. The direction of orthodontic tooth movement to camouflage a very mild midface deficiency is opposite to that of tooth movement required to prepare a patient for midface advancement surgery.

Patients with no skeletal deformity

If a cleft patient in permanent dentition presents with no skeletal deformity (anteroposterior transverse or vertical), then the management of the dental malocclusion does not differ very much from that of the noncleft patient. Patients with isolated clefts of the lip and alveolus or clefts of the soft palate may fall into this group and will benefit from fixed orthodontic treatment alone. The dental malocclusion may be limited to mild dental anterior or posterior crossbites, rotated and malposed teeth, and missing the lateral incisor in the cleft area. Mild anterior crossbites can be corrected with an advancing arch wire and posterior crossbite with archwire expansion or with a removable quad helix.

There are two options regarding management of a missing lateral incisor: Either maintenance of the space for a dental implant or movement of the canine into the lateral incisor space, recontouring it to resemble a lateral incisor. If the decision is made to maintain space for a dental implant, optimal space must be made available for the implant to replace the missing lateral incisor. During active orthodontic treatment, this space can be maintained with the use of a pontic tooth that contains a bracket and is ligated to the orthodontic archwire. At the conclusion of treatment, a cosmetic removable prosthesis should be fabricated to maintain the space. Once craniofacial skeletal growth is complete, a single tooth implant can be placed.

If canine substitution is planned for replacement of the missing lateral incisor, then several canine crown modifications are needed to achieve optimal esthetics. The permanent canine will need recountering on incisal, labial, mesial, distal, and lingual surfaces. Recontouring can be done progressively during active orthodontic treatment. When bonding this tooth, a lateral incisor bracket will be placed more gingivally, to bring its gingival margin down to the level of the adjacent central incisor. The first bicuspid will then take the canine position and will also need reshaping to resemble a permanent canine. The second premolar and first and second molars are moved mesially. The patient's orthodontic treatment is completed with a Class II occlusal relationship on the side of the missing lateral incisor. With successful esthetic bonding, excellent results can be achieved with this option.

Patients with mild skeletal discrepancy

In patients presenting with mild skeletal discrepancy and minimal esthetic concern, orthodontic dental compensation may be recommended. A thorough clinical exam, growth status and stature, hand-wrist films, and serial cephalometric assessments need to be performed before suggesting this option. However, the patient and the family should be cautioned that the outcome can be compromised if the patient outgrows the dental compensation and ultimately may need extended orthodontic treatment to remove the compensations and prepare for orthognathic surgery. Proclination of the maxillary incisors and lingual inclination of the lower incisor can adequately camouflage a mild skeletal discrepancy.

Patients with moderate to severe skeletal discrepancy

Patients presenting with moderate to severe skeletal discrepancy may achieve the best esthetic and functional results through a combination of orthodontic treatment that is carefully coordinated with orthognathic surgery.

Depending on the severity of the skeletal discrepancy, the patient may require only maxillary advancement or a combination of maxillary advancement and mandibular setback. If the surgical/orthodontic option is elected, timing of the orthodontic and surgical treatment becomes critical [Figure 5].

Under optimal conditions, it is recommended to remove all dental compensations and to align the teeth in an optimal position relative to the skeletal base and alveolar processes. The orthodontist will plan the coordination of maxillary and mandibular arch widths by hand articulating the progressing dental study models into the predicted postsurgical occlusion. Once the presurgical orthodontic treatment goals are achieved (coordinated maxillomandibular arch width, compatibility of occlusal plans, satisfactory intercuspation), the patient may be debonded and placed on removable retainers until craniofacial skeletal growth is complete. This assessment is made by observation of the closing sutures in the hand-wrist radiographs, by measurements of mandibular body length in serial lateral cephalograms and measurements of change in stature or height. The patient is placed on fixed orthodontic appliances for a short, presurgical orthodontic treatment phase before orthognathic surgery. The combined surgical and orthodontic treatment goals are planned in close coordination with the surgeon. After the surgical correction is completed, a 12-month postsurgical orthodontic phase of treatment begins. The objectives of postsurgical orthodontics are to balance the forces of skeletal relapse with intermaxillary elastics, to observe the skeletal stability of the surgical correction, and to detail the postsurgical occlusion.

Sometimes, a maxillomandibular skeletal discrepancy is severe, and for psychosocial reasons, early surgery during the mixed or permanent dentition is indicated. However, the patient and their family must be cautioned that the patient may outgrow the surgical orthodontic correction and may need another corrective surgery on the completion of skeletal growth. In these cases, distraction osteogenesis may be considered as an alternative. The advantages of distraction osteogenesis in a growing patient with cleft lip and palate include the generation of new bone at the site of the osteotomy, large advancement without the need for a bone graft, and gradual stretching of the scared soft tissue. Since distraction osteogenesis and midface advancement are performed at the rate of 1 mm/day, changes in velopharyngeal competence can be monitored during the advancement. For the skeletally mature cleft patient who shows a severe maxillary deficiency, advancement of the midface with distraction osteogenesis is also a good treatment option [Figure 6].

Distraction in the cleft patient can be achieved with external or internal distraction devices. Depending on the surgeon's preference and clinical presentation of deformity, either approach may be used to achieve the desired results. Internal distraction devices are more acceptable to the patient; however, they offer some clinical limitations. The external devices can be adjusted to change the vector of skeletal correction during the active phase of distraction while the internal device cannot be adjusted in this way. After the Le Fort I osteotomy and a latency period of 5–6 days, the distraction device is activated at the rate of 1 mm/day until the desired advancement is achieved. Interarch elastics may be used during the active phase of distraction osteogenesis to guide the maxilla to its optimal position and the teeth to optimal occlusion. On completion of the advancement, there is an 8-week period of bone consolidation during which time the distraction devices serve as skeletal fixation appliances. Following this period of bone healing, the distraction devices are removed, and postdistraction orthodontics begins. The objective of postdistraction orthodontics is to retain the position of the advanced midfacial skeleton and to fine tune the occlusion.

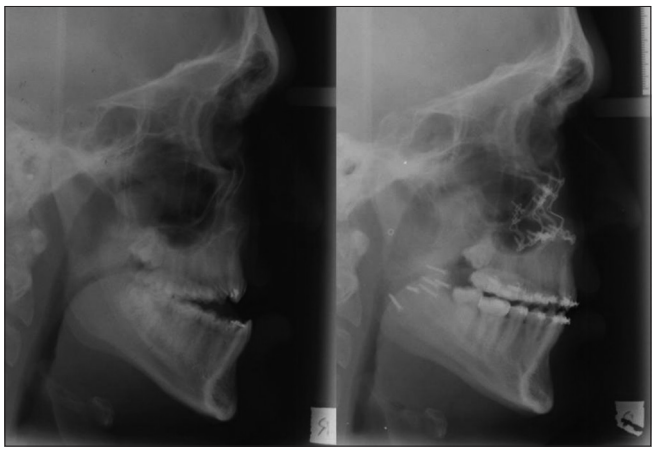

Figure 5: Bilateral cleft patient with two-jaw surgery. Lateral cephalogram pre- and post-surgery

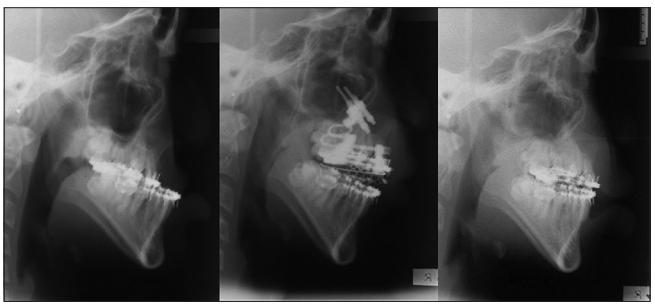

Figure 6: Series of patients treated for Le Fort I midface advancement with internal distraction: Lateral cephalograms before, during, and after internal midface distraction

CONCLUSION

The successful management of a patient with cleft lip and palate requires careful coordination of all members of the cleft palate team. The introduction of NAM has significantly changed the outcome of cleft treatment. The shape, form, and nasal esthetics of patients with clefts are significantly better in those who have had the benefits of NAM. Clinical techniques constantly will be improved to enable the clinician to provide the best possible care while striving to reach the goal of excellent facial esthetics in patients born with clefts.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Grayson BH, Cutting C, Wood R. Preoperative columella lengthening in bilateral cleft lip and palate. Plast Reconstr Surg 1993;92:1422-3.
2. Sischo L, Broder HL, Phillips C. Coping with cleft: A conceptual framework of caregiver responses to nasoalveolar molding. Cleft Palate Craniofac J 2015;52:640-50.
3. Rubin MS, Clouston S, Ahmed MM, M Lowe K, Shetye PR, Broder HL, *et al.* Assessment of presurgical clefts and predicted surgical outcome in patients treated with and without nasoalveolar molding. J Craniofac Surg 2015;26:71-5.
4. Maull DJ, Grayson BH, Cutting CB, Brecht LL, Bookstein FL, Khorrambadi D, *et al.* Long-term effects of nasoalveolar molding on three-dimensional nasal shape in unilateral clefts. Cleft Palate Craniofac J 1999;36:391-7.
5. Cutting C, Grayson B, Brecht L, Santiago P, Wood R, Kwon S. Presurgical columellar elongation and primary retrograde nasal reconstruction in one-stage bilateral cleft lip and nose repair. Plast Reconstr Surg 1998;101:630-9.
6. Pfeifer TM, Grayson BH, Cutting CB. Nasoalveolar molding and gingivoperiosteoplasty versus alveolar bone graft: An outcome analysis of costs in the treatment of unilateral cleft alveolus. Cleft Palate Craniofac J 2002;39:26-9.
7. Patel PA, Rubin MS, Clouston S, Lalezaradeh F, Brecht LE, Cutting CB, *et al.* Comparative study of early secondary nasal revisions and costs in patients with clefts treated with and without nasoalveolar molding. J Craniofac Surg 2015;26:1229-33.
8. Lee CT, Grayson BH, Cutting CB, Brecht LE, Lin WY. Prepubertal midface growth in unilateral cleft lip and palate following alveolar molding and gingivoperiosteoplasty. Cleft Palate Craniofac J 2004;41:375-80.
9. Santiago PE, Grayson BH, Cutting CB, Gianoutsos MP, Brecht LE, Kwon SM. Reduced need for alveolar bone grafting by presurgical orthopedics and primary gingivoperiosteoplasty. Cleft Palate Craniofac J 1998;35:77-80.
10. Sato Y, Grayson BH, Garfinkle JS, Barillas I, Maki K, Cutting CB. Success rate of gingivoperiosteoplasty with and without secondary bone grafts compared with secondary alveolar bone grafts alone. Plast Reconstr Surg 2008;121:1356-67.
11. Ross RB. Treatment variables affecting facial growth in complete unilateral cleft lip and palate. Cleft Palate J 1987;24:5-77.