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CHAPTER 28

Multidisciplinary Team Approach to Cleft Lip and Palate Management

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CHAPTER OUTLINE

Cleft lip and palate, the most common of the craniofacial anomalies, are severe congenital anomalies that have an incidence of 0.28 to 3.74 per 1000 live births globally. In the United States, cleft lip and palate occur in approximately 1 in 1000 newborns. The incidence varies widely among races. Cleft lip and palate occur in about 1 in 800 white newborns, 1 in 2000 black newborns, and 1 in 500 Japanese or Navaho Indian newborns. Isolated cleft palate occurs in about 1 in 2000 newborns and demonstrates less racial variation. Cleft lip and palate together account for approximately 50% of all cases, whereas isolated cleft lip and isolated cleft palate each occur in about 25% of cases. Many of these congenital anomalies appear to be genetically determined, although the majority are of unknown cause or are attributable to teratogenic influences (see Chapter 6).

CLASSIFICATION OF CLEFT LIP AND PALATE

There is a tendency to conceptualize cleft lip and palate as a homogenous anomaly. If that was true, a treatment plan applicable to all cases could be formulated. However, the reality is that clefts vary widely in their clinical presentations (Fig. 28-1).

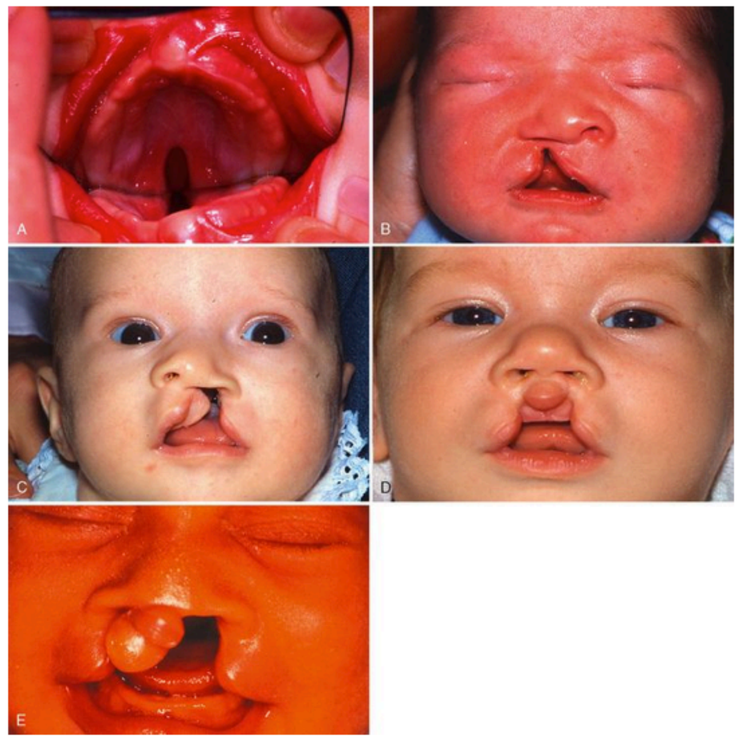


Figure 28-1 Various clinical presentations of cleft lip and cleft palate. (See text for descriptions of each specific type.) **A,** Isolated cleft palate (class II). **B,** Unilateral cleft of the lip (class II). **C,** Unilateral complete cleft of the lip and palate (class III). **D,** Bilateral incomplete cleft of the lip (class IV). **E,** Bilateral complete cleft of the lip and palate with a laterally displaced premaxillary segment (class IV).

To standardize reporting of cleft lip and palate, the Nomenclature Committee of the American Association of Cleft

Palate Rehabilitation devised a classification system that later was adopted by the Cleft Palate Association. The complexity of this system, however, has made its acceptance less than overwhelming. Veau proposed the most frequently used system.[1] He classified clefts of the lip as follows:

- Class I—a unilateral notching of the vermilion not extending into the lip
- Class II—a unilateral notching of the vermilion border, with the cleft extending into the lip but not including the floor of the nose
- Class III—a unilateral clefting of the vermilion border of the lip extending into the floor of the nose
- Class IV—any bilateral clefting of the lip, whether it be incomplete notching or complete clefting

Veau divided palatal clefts into four classes as follows (Fig. 28-2):

- Class I—involves only the soft palate
- Class II—involves the soft and hard palates but not the alveolar process
- Class III—involves both soft and hard palates and the alveolar process on one side of the premaxillary area
- Class IV—involves both soft and hard palates and continues through the alveolus on both sides of the premaxilla, leaving it free and often mobile

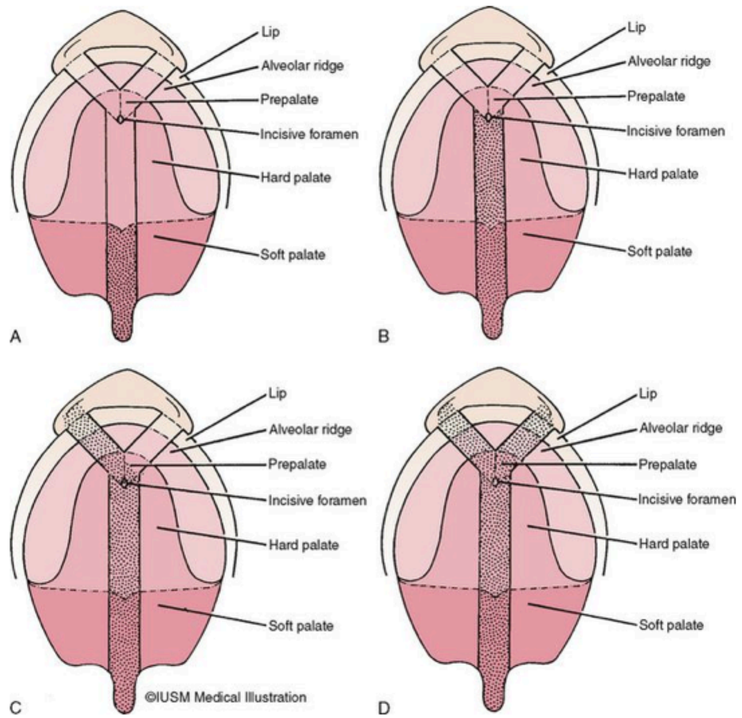


Figure 28-2 Veau's classification of cleft lip and palate. Shaded area, Extent of the cleft. **A,** Class I cleft of the soft palate only. **B,** Class II cleft of the soft and hard palate but not involving the alveolar process. **C,** Class III unilateral complete cleft of the lip and palate. **D,** Class IV bilateral complete cleft of the lip and palate.

Veau did not include submucous clefts of the palate in his classification system. Submucous clefts may frequently be diagnosed by the following physical findings: bifid uvula, palpable notching at the posterior portion of the hard palate, and a zona pellucida (thin, translucent membrane). Submucous clefts of the palate may be associated with an incomplete velopharyngeal mechanism or eustachian tube dysfunction.

MULTIDISCIPLINARY CLEFT LIP AND PALATE TEAM

Children born with cleft lips and palates have many problems that need to be solved for successful habilitation. The complexity of these problems requires that numerous health care practitioners cooperate in providing the specialized knowledge and skills necessary to ensure comprehensive care. The cleft palate team concept has evolved from that need.

To address the many treatment regimens and different care protocols, the American Cleft Palate– Craniofacial Association (http://www.cleftpalate-craniofacial.org) convened a consensus conference on recommended practices for the care of patients with craniofacial anomalies. This conference produced the document "Parameters for Evaluation and Treatment of Patients with Cleft Lip/Palate or other Craniofacial Anomalies."[2] This serves as a guide for implementing the multidisciplinary approach to cleft and craniofacial care and is used by teams in the United States and Canada.

Because optimal care is best achieved by multiple types of clinical expertise, the teams may be composed of individuals in (1) the dental specialties (orthodontics, oral surgery, pediatric dentistry, and prosthodontics), (2) the medical specialties (genetics, otolaryngology, pediatrics, plastic surgery, and psychiatry), and (3) allied health care fields (audiology, nursing, psychology, social work, and speech pathology).

These care providers assess the patient's medical status and general development, dental development, facial esthetics, psychological well-being, hearing, and speech development (Fig. 28-3). Team members must communicate effectively among themselves, with the child and parents, and with the primary care physician and dentist. Individuals on the team must respect one another's opinions and be flexible in planning and carrying out therapy. Periodic evaluation is necessary to assess the effect of previous therapy and to determine whether an alternative approach may be necessary. A team conference immediately after patient examination is a desirable way to discuss current problems and plan timely therapy.

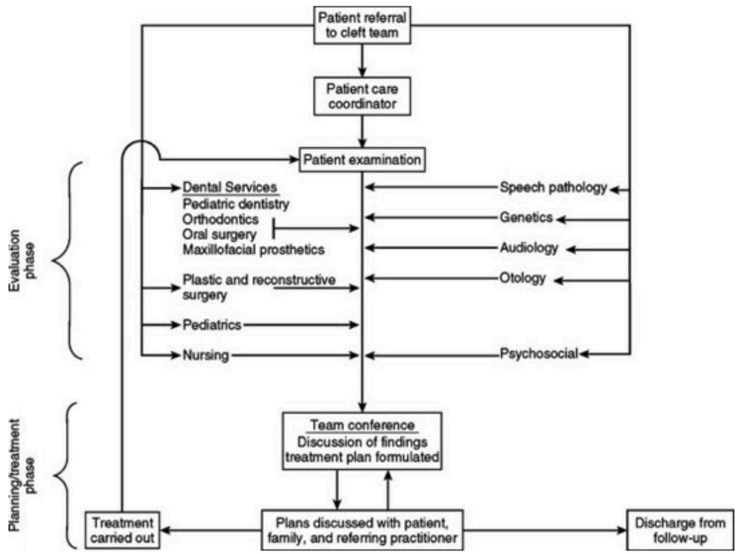


Figure 28-3 Diagram of patient interaction with members of the cleft lip and palate team.

Whitehouse describes the clinical team as a "close, cooperative, democratic, multiprofessional union devoted to a common purpose—the best treatment of the fundamental needs of the patient."[3]

GENERAL RESPONSIBILITIES OF TEAM MEMBERS

DENTAL SPECIALTIES

The pediatric dentist is responsible for the overall dental care of the patient. Numerous dental anomalies and malocclusions occur with a cleft lip or palate. These may be attributed to the congenital clefting itself or may be secondary to the surgical correction of the primary defects. A high correlation is found between the number and severity of dental problems and the type and severity of the cleft.

The pediatric dentist should discuss with the patient and parents the traditional dental problems associated with clefting. Any one, or several, of the following conditions may occur with a significantly greater frequency than in the general population:

1. Natal, or neonatal, teeth are usually maxillary central incisors observed in patients with a complete unilateral or bilateral cleft palate (Fig. 28-4).

2. There is a high incidence of congenitally absent teeth, especially the primary or permanent lateral incisor area adjacent to the alveolar cleft. There is also an increased incidence of congenitally missing premolars.

3. There is a significant increase in the frequency of supernumerary teeth (Fig. 28-5), which are often seen in those with complete unilateral or bilateral clefts. Again, the primary lateral incisors are most frequently absent. Occasionally, there can be supernumerary teeth and congenitally missing teeth in patients with cleft lip only with or without notching of the alveolus.

4. It is common to find ectopic primary lateral incisors located palatally, adjacent to, or within the cleft site. In the permanent dentition, canines on the side of the complete alveolar cleft may erupt palatally into the cleft.

5. Various anomalies of tooth morphology are frequently seen in association with complete unilateral and bilateral clefts of the palate. These include enamel hypoplasia, microdontia or macrodontia, fused teeth, and aberrations in crown shape. The teeth most often affected are the primary and permanent maxillary incisors.

6. Permanent teeth that erupt adjacent to a cleft of the alveolar ridge usually have a deficiency of supporting alveolar bone about the root surfaces. These teeth are susceptible to premature loss. A decrease in alveolar bone support may be accentuated when periodontal disease is present or when orthodontic appliance therapy is used indiscriminately.

7. With great frequency, permanent central incisors adjacent to an alveolar cleft erupt in a rotated position and with deviations of axial root inclination.

8. With a complete cleft of the palate and alveolus there is no longer a contiguous maxillary arch. External forces applied to the maxilla (e.g., by muscles of mastication or by the contraction of scar tissue after surgical repair of the cleft palate) can result in medial collapse of the posterior segments. A posterior crossbite may be observed unilaterally or bilaterally.

9. In an infant with a complete bilateral cleft of the lip and palate, the premaxilla is often protuberant and mobile. There may be a greater than 100% overbite with subsequent stripping of the labial-attached gingiva overlying the mandibular incisors (Fig. 28-6). Traumatic anterior end-to-end occlusion, or an anterior crossbite, is also common.

10. In a patient with a complete unilateral or bilateral cleft of the palate, the lateral facial profile may appear noticeably convex (Fig. 28-7). This may become more perceptible as the child grows older. The appearance may be attributed to a true mandibular or pseudomandibular prognathism. In pseudomandibular prognathism, the maxilla is in spatial disharmony with the mandible. This may be caused by a retrognathic maxilla or an attenuation of the anteroposterior and vertical growth of the maxilla.

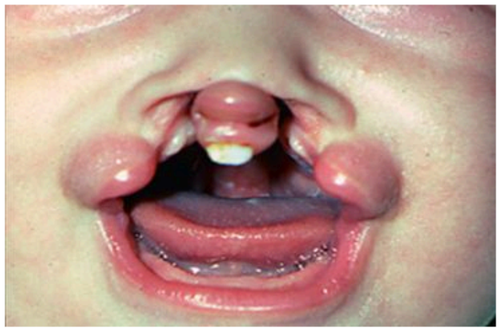


Figure 28-4 Neonatal maxillary central incisor in a newborn infant with a bilateral complete cleft of the lip and palate.

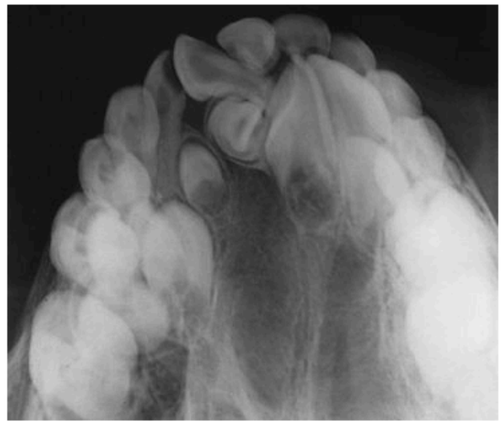


Figure 28-5 Maxillary occlusal radiograph demonstrating supernumerary maxillary central incisors.

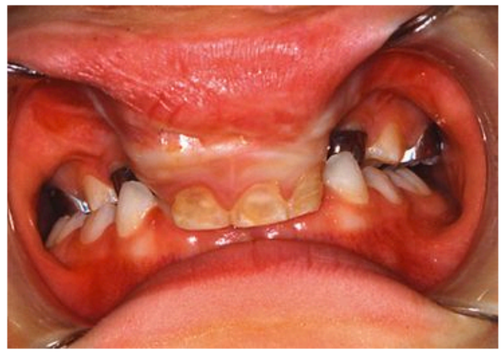


Figure 28-6 Bilateral complete cleft of the lip and palate demonstrating a greater than 100% overbite. Stripping of the labial attached gingiva of the mandibular central and lateral incisors is common in this presentation.

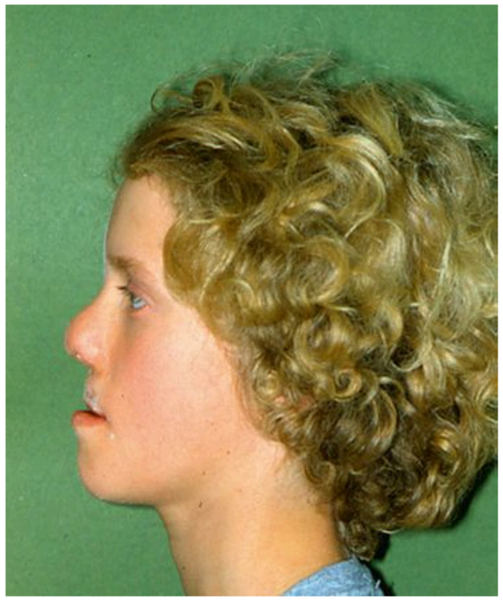


Figure 28-7 Lateral facial profile of an adolescent boy with a repaired bilateral complete cleft of the lip and palate. Maxillary hypoplasia, secondary to the cleft defect, often produces a greatly concave lateral facial profile.

Parents are often so overwhelmed by other aspects of the cleft that they give dental care a low priority or even neglect it altogether. Preventive dental care is extremely important in these cases. The intact dental occlusion is the foundation around which future orthodontic therapy takes place. For this reason, optimum dental health is essential for total habilitation of the patient. Any compromise will lead to a less than optimal result. Routine prophylaxis and fluoride treatments are mandatory. Referral for preventive dental care should be made during the first year of life. Fluoride supplements, dentifrices, and rinses are indicated if the patient lives in a nonfluoridated community. The parents and patient should be instructed in proper dental hygiene techniques, especially around the defect. Close communication between the primary care dentist and the cleft team is important to ensure the continuity of care necessary during the extended treatment of such patients. Routine periodic reports from the cleft team should be forwarded to the child's primary care dentist, especially during orthodontic or surgical treatment. Pediatric dentists often are involved in the presurgical and postsurgical treatment phase of maxillary orthopedics. Both active and passive appliances are used to bring the cleft segments into a more ideal alignment and thereby promote a more favorable initial surgical outcome.

The orthodontist plays a key role in the diagnosis and treatment of a cleft condition by obtaining records necessary for diagnosis and treatment planning. These include cephalometric and panoramic radiographs, study models, and diagnostic photographs. Analysis of these records enables the orthodontist to describe and quantitate the facial skeleton and soft tissue deformities. Using expertise in the growth and development of the facial skeleton, this specialist can identify problem areas and, with some limitations, predict growth and development. Many team members depend on the orthodontist's analysis and quantitations of the cleft anomaly for treatment planning.

The orthodontist also provides comprehensive orthodontic care for patients. Most orthodontic care can be considered conventional, but for difficult dental configurations, innovation and imagination are required for treatment. If surgical treatment is indicated, the orthodontist works closely with the surgeon to plan the most appropriate procedure. Immediate postoperative function, esthetic result, and long-term stability are factors considered before surgery.

The ability to surgically alter skeletal relationships of the maxillomandibular complex is the basis for participation by the oral and maxillofacial surgeon on the cleft team. This specialist evaluates all patients for facial form and function and jaw position. Many patients have significant skeletal malocclusions that cannot be treated by conventional orthodontics and require surgical correction.

The surgical placement of primary and secondary alveolar cleft bone grafts is another important role of the oral and maxillofacial surgeon. These grafts aid in dental habilitation. The grafted bone supports the teeth adjacent to the cleft site and provides bone through which teeth may erupt. A detailed discussion of these grafts follows later in this chapter.

The maxillofacial prosthodontist replaces, restores, or rehabilitates orofacial structures that may be congenitally missing or malformed. Nonliving materials are used to restore and enhance

form and anatomy. There is a special commitment to the oral cavity because this specialist fabricates prosthetic appliances to rehabilitate mastication, deglutition, speech, and oral esthetics.

Many patients with clefts have congenitally missing teeth or malformed teeth that may need to be removed. In these cases, masticatory function, speech, and orofacial esthetics are compromised, and successful habilitation dictates that these missing teeth be replaced to achieve as near normal a condition as possible (Fig. 28-8). The maxillofacial prosthodontist may do this with fixed or removable appliances or with a combination of the two.

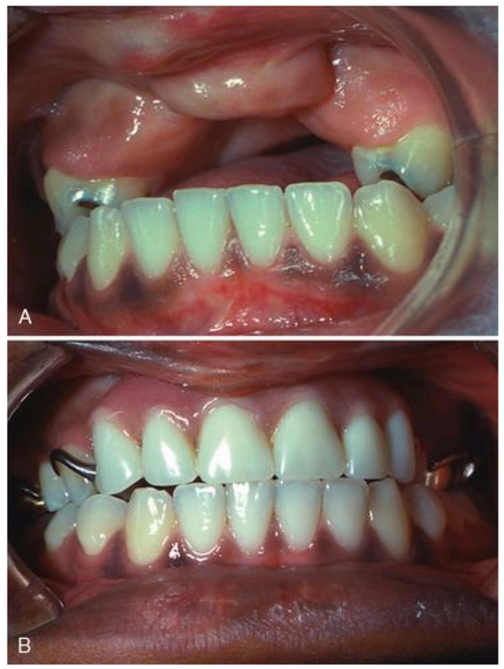


Figure 28-8 A, Bilateral complete cleft of the lip and palate in which the maxillary six permanent anterior teeth have been removed. **B,** Removable prosthodontic appliance providing acceptable occlusal and esthetic results.

Occasionally, patients demonstrate aberrant speech patterns caused by failure of the soft palate to elevate properly. In such cases, a palatal lift appliance is fabricated to aid the speech mechanism. In other cases the maxillofacial prosthodontist may fabricate a speech bulb prosthesis to aid or augment the velopharyngeal mechanism. In patients with considerable escape of air through persistent palatal fistulas, the fistulas can be obturated (Fig. 28-9).

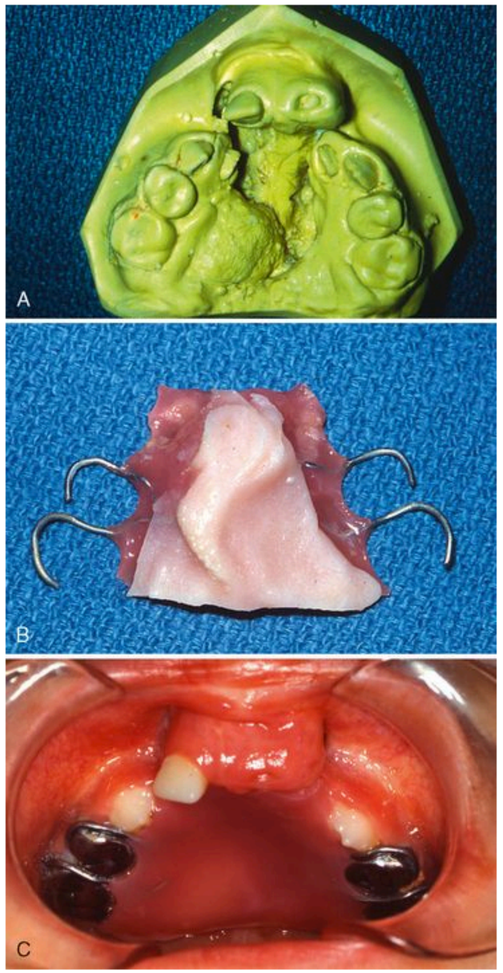


Figure 28-9 A, Diagnostic maxillary model of a bilateral complete cleft of the lip and palate. Notice the large patent oronasal fistula that resulted after several attempts to close the defect surgically. **B,** Maxillary prosthesis constructed for the patient to obturate the palatal defect. **C,** Palatal prosthesis in place. This closure provides a reduction in the amount of fluids and foods that enter the nasal cavity during eating. The closure also facilitates more normal speech production.

MEDICAL AND ALLIED HEALTH SPECIALTIES

The patient care coordinator arranges appointments, maintains patient records, and monitors the interaction of the patient and family with the various team members. The coordinator corresponds with health and school personnel near the patient's home to help provide continuity of care for the cleft patients within the community. The coordinator is the most convenient point of contact with team members for the patients, their families, and health care practitioners outside the medical center complex.

The pediatrician, often the patient's own pediatrician or family physician, is responsible for maintenance of the patient's overall health. This specialist performs complete physical evaluations and helps assess the patient's physiologic status. Close attention is also directed to growth status and other developmental milestones.

The medical geneticist examines the patient to find characteristics of syndromes associated with cleft lip and palate. Consideration is given to the genetic basis for the anomaly, and this information is related to the parents. Genetic counseling is a very important function of the geneticist. Parents are vitally interested in risk assessment relative to future offspring, and other family members who may be at risk are often counseled (see Chapter 6).

The role of the plastic and reconstructive surgeon usually begins with a determination of the timing and method of lip closure. With complete clefts, the plastic surgeon may next be responsible for obtaining bone grafts to be used in closing defects of the maxillary dental alveolus. This specialist is also involved in cleft palate repair.

An additional responsibility may be to conduct a nasopharyngoscopic examination of the speech mechanism. If a defect is identified, the plastic surgeon may perform a pharyngoplasty to improve velopharyngeal function. The final role is to correct internal or external cleft nasal deformities.

The social worker acts as the patient's advocate in many cases and aids in psychosocial assessment. This team member assists the family by making referrals to persons or agencies at the local, county, and state levels for guidance regarding financial resources for medical care. During hospitalization, the social worker provides supportive counseling and facilitates communication between the family and medical or hospital personnel. The focus is on helping the family cope with stress during and after surgery and on dealing with emotional factors involved in forming realistic expectations of surgical outcomes and in adapting to problems of body image.

The psychiatrist and psychologist evaluate the patient for strengths and weaknesses in cognitive, interpersonal, emotional, behavioral, and social development. Emphasis is placed on the patient's ability to cope with the emotional and physical stress created by the cleft defect. Consultation with the parents and school regarding educational or behavioral management occurs when indicated.

The speech pathologist functions essentially as a monitor of speech output. All speech sounds are analyzed to determine deviations from normal, and the cause of any deviation is evaluated. To the extent that anatomic variations are corrected, the speech pathologist offers therapeutic options to enhance maturation of speech or to achieve satisfactory compensation in motor production for optimal speech.

The audiologist performs tests to identify any hearing difficulties. When neither the child nor the parents recognize hearing problems, the result can be a delay in speech and language development and poor performance in school. When hearing tests or impedance measures are abnormal, a referral is made to an otolaryngologist for an ear examination. The otolaryngologist coordinates audiologic tests and any special studies that may be needed to evaluate middle ear structures. Any middle ear surgery that is to be done is performed by this member of the team. He or she also may perform a nasopharyngoscopic examination in coordination with the speech pathologist.

Nurses provide varying functions that are valuable to the cleft lip and palate team. They actively communicate with other disciplines in passing on information regarding the special needs of each child and family. Nurses emphasize total family involvement, not just treatment of the patient. They prepare patients and families for either outpatient or inpatient surgery and assist in the overall management process. Above all, they are extremely important in assessing the initial feeding issues and advising parents with ongoing nutritional concerns.

The presence of more complex craniofacial anomalies, such as Crouzon syndrome, Treacher-Collins syndrome, or hemifacial microsomia, require additional specialists on the team because there is more deformity. Some of these care providers include anesthesiologists, diagnostic medical imaging radiologists, neurologists, neurosurgeons, and ophthalmologists in addition to those cleft team providers already mentioned.

MULTIDISCIPLINARY SEQUENCING OF TREATMENT IN CLEFTS

The following discussion focuses on major treatment procedures performed by members of the cleft team. For convenience, treatment is divided into four stages, which generally correspond to stages in the child's dental development.

STAGE I (MAXILLARY ORTHOPEDIC STAGE: BIRTH TO 18 MONTHS)

Management of the patient with a cleft begins with immediate attention to the needs of the newborn. Feeding problems are often associated with cleft anomalies, which make it difficult for the infant to maintain adequate nutrition. These problems include insufficient suction to pull milk from the nipple, excessive air intake during feeding (requiring several burpings), choking, nasal discharge, and excessive time required to take nourishment.

McNeil in the 1950s[4,5] and other authors since then have advocated various prosthetic appliances, both active and passive, for the treatment of infants born with unilateral and bilateral clefts of the lip and palate. One such prosthesis, an intraoral maxillary obturator, has proved beneficial by providing an artificial palate. The advantages of this prosthetic therapy include the following:

1. Provides a false palate against which the infant can suck, reduces the incidence of feeding difficulties in newborns, and helps maintain adequate nutrition

2. Provides maxillary cross-arch stability and prevents arch collapse after definitive cheiloplasty (surgical closure of the lip)

3. Provides maxillary orthopedic molding of the cleft segments into approximation before primary alveolar cleft bone grafting

In a study by Jones, maxillary obturators were constructed to facilitate feeding for 51 infants with unilateral or bilateral cleft lip and palate.[6] From birth, each infant had continuously experienced feeding difficulties before obturator therapy. After the infants had worn the obturator for at least 8 months, parents reported that they were more comfortable while feeding their infants and that nasal discharge was reduced. The time required for feeding and the difficulty experienced by the parents were also reduced. Of particular importance was the reported reduction of parental apprehension during feeding. All parents recommended the obturator for others who have infants with cleft lips and palates. It was also reported that the weights of the infants at 1, 3, and 6 months of age consistently remained at, or above, the 50th percentile compared to normative growth data. No fluctuation in weight was noted even after primary lip closure at about 3 months of age.

Not all clinicians who work with infants with cleft lips and palates advocate use of prosthetic feeding appliances. Some believe that such appliances are not effective in facilitating feeding. Pashayan and McNab recommend using a standard nipple that has been crosscut.[7] This enlarged cut provides improved ejection of the milk into the infant's mouth with a minimum of effort. Although this recommendation is appropriate for infants born with isolated clefts of the palate, obturator construction is generally indicated for those born with complete clefts of the lip and palate. This is especially important in consideration of the maxillary orthopedic molding of the alveolar segments after surgical closure of the lip. In a recent survey, it was reported that approximately 32% of cleft teams in the United States and Canada use this prosthetic feeding appliance.

Impression Technique and Obturator Construction

An alginate impression of the infant's maxillary arch is made with a modified stock tray. Ideally, this is accomplished as soon after birth as possible. The infant is held upright during the impression process to prevent aspiration of excess material (Fig. 28-10). Appropriate emergency equipment, including forced oxygen, suction, and standard airway management equipment, should be available. The impression should exhibit good anatomic detail with coverage of the entire maxillary arch (Fig. 28-11). A stone model is then produced. The steps in obturator construction are as follows:

1. Block out excessive undercuts with modeling dough or wax. Modeling dough is preferred because it is easy to remove from the finished prosthesis.

2. Apply a tinfoil substitute over the entire surface of the maxillary model and let it dry.

3. If necessary, place a dam of modeling dough on the back of the model to hold the resin in the palatal defect while curing.

4. Pour a mixture of soft, autopolymerizing acrylic resin into the cleft to the level of the palate. This provides retention for the prosthesis by gently contouring into the available undercuts (Fig. 28-12).

5. Place the model in a warm, moist environment to cure for 20 minutes.

6. Add autopolymerizing acrylic resin to the palate using a "salt and pepper" method, making sure the acrylic resin extends well into the mucobuccal fold area (Fig. 28-13).

7. Remove the appliance from the model, and rinse the wax and modeling dough off with hot water. Then trim and polish the appliance.

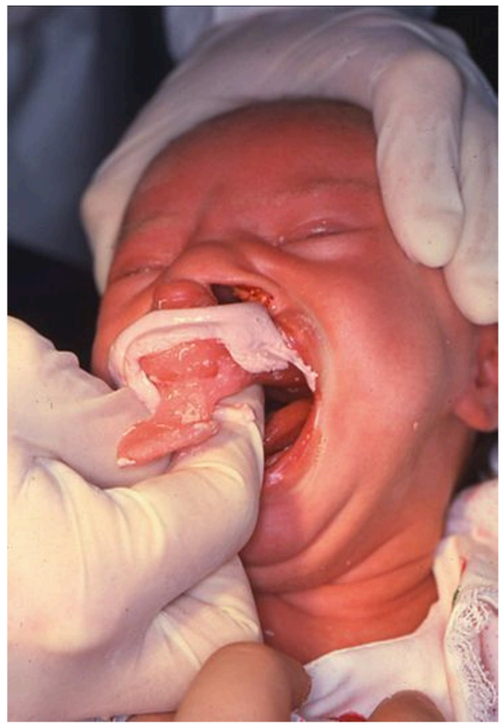


Figure 28-10 Maxillary impression for obturator construction on a newborn with a cleft lip and palate. The infant is held in an upright position to prevent aspiration of excess material.

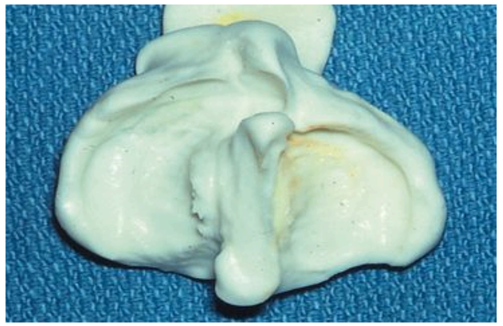


Figure 28-11 Final impression of the infant's maxillary arch. Notice the extension of the material into the cleft defect, as well as the roll produced in the buccal fold. Attention to such detail ensures an excellent reproduction of the intraoral architecture for obturator construction.

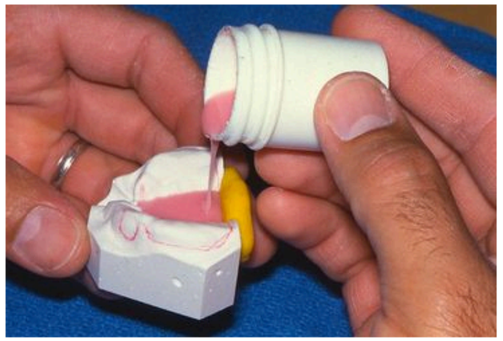


Figure 28-12 Application of soft, autopolymerizing resin into the cleft to the level of the palate. This material provides increased retention of the obturator by contouring into the cleft. Notice the dam of modeling dough, which aids in the placement of the resin.

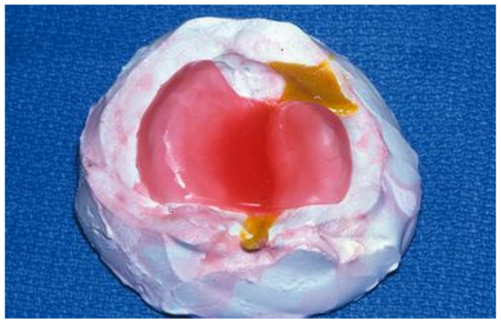


Figure 28-13 Maxillary model at the completion of the application of autopolymerizing acrylic resin. The obturator is allowed to cure for 20 minutes and then is trimmed and polished. Notice the extension of the resin into the mucobuccal fold. This extension further increases the retention of the prosthesis.

Clinical Management of Initial Obturator Therapy (Birth to 3 Months)

The appliance is positioned in the infant's mouth (Fig. 28-14). Areas of excessive pressure on any intraoral tissues by the acrylic resin are identified by observation and then reduced. Care is taken to keep the acrylic resin from impinging on muscle attachments or extending to the depth of the buccal vestibule. Parents are instructed in placement and removal of the appliance and its daily cleaning. Infants are usually seen for adjustments 2 days after appliance delivery. Monthly observations are then scheduled. In most cases, this appliance will serve until the time of initial lip closure at approximately 3 months of age. The major advantage of obturator use during this stage is to enhance the child's ability to obtain nourishment.

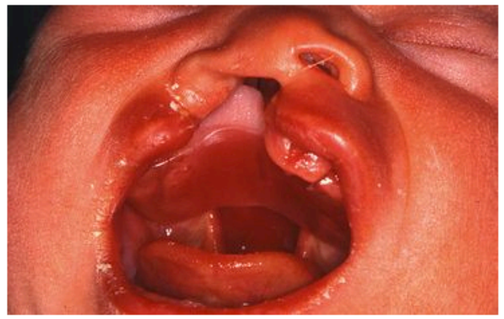


Figure 28-14 Obturator in place on the infant's maxillary arch. Notice the extension of the soft resin into the cleft defect, which provides increased retention.

(From Jones JE, Kerkhof RL. Obturator construction for maxillary orthopedics in cleft lip and palate infants, Quintessence Dent Technol 8:583-586, 1984.)

Premaxillary Orthopedics (Birth to 4 or 5 Months)

In some cases of bilateral cleft lip and palate, the infant has a premaxillary segment positioned severely anterior to the maxillary arch segments or deviated laterally to one side of the cleft defect (Fig. 28-15). This presents a difficult clinical challenge for the surgeon before surgical closure of the lip. If lip surgery is undertaken with the premaxilla in such an abnormal position, the chances of lip dehiscence (lip separation caused by increased pressure at the suture lines) are increased.

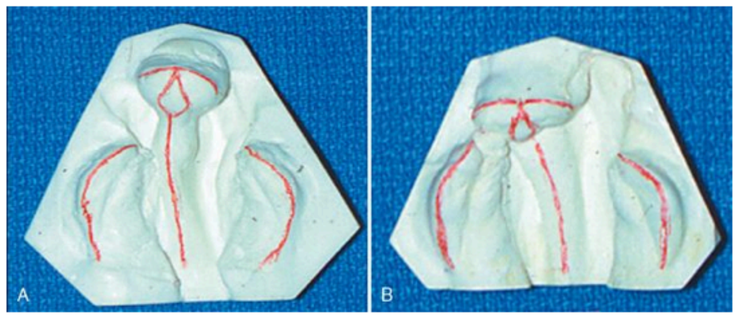


Figure 28-15 Representative diagnostic models of two clinical presentations in bilateral complete cleft of the lip and palate. **A,** Severe anteroposterior protrusion of the premaxillary segment. **B,** Severe anteroposterior protrusion of the premaxillary segment with a lateral deviation.

As early as 1686, Hofman described the use of a head cap and premaxillary strap to reposition the premaxilla.[8] This type of apparatus is useful for anteroposterior and vertical repositioning. The following describes the construction and orthopedic management of the typical clinical presentations: an anteriorly positioned maxilla and a laterally displaced premaxilla.

As soon as possible (usually within 2 weeks of birth), an impression is made of the infant's maxillary arch for construction of an intraoral obturator in the manner previously described. After delivery of the obturator, the infant is allowed to become accustomed to the appliance for 1 week. At the second appointment, the infant is fitted with a premaxillary retraction appliance.

Appliance Construction for Premaxillary Retraction

A baby bonnet is made to provide "headgear" anchorage for a premaxillary retraction strap. An elastic strap is placed over the protruding premaxilla and anchored to the infant's head using the bonnet. By the application of sequentially increasing equal forces to the premaxilla, the premaxilla is retropositioned into a more normal position relative to the maxillary segments. This bonnet-and-strap appliance is worn 24 hours a day and is removed only for feeding. The desired movement can usually be accomplished within 6 to 8 weeks (Fig. 28-16).

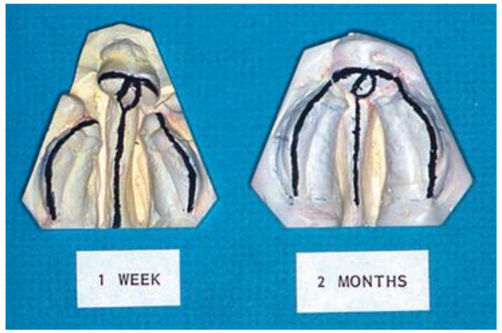


Figure 28-16 Diagnostic models for an infant with a complete bilateral cleft of the lip and palate at 1 week of age (before premaxillary retraction therapy is begun) and at 2 months of age (at the completion of premaxillary retraction therapy). Notice the essentially normal position of the premaxillary segment within the lateral palatal segments.

In many cases the use of soft, elastic tape (Microfoam Tape; 3M, St. Paul, Minn.) can be used to retract the premaxillary segment in a simpler manner than with the bonnet retraction system (Fig. 28-17). The advantages are its ease in fabrication; however, it does not afford the same control of the force direction and therefore cannot be used in all instances.

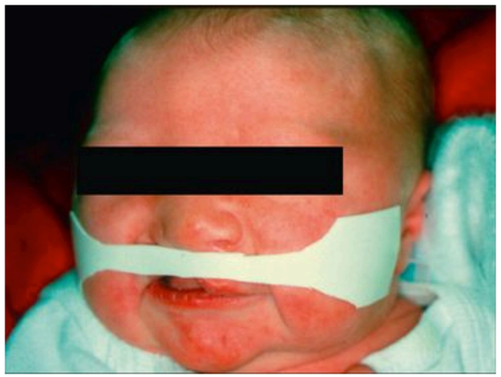


Figure 28-17 Premaxillary retraction using soft elastic tape (Microfoam Tape, 3M).

In the case of a laterally deviated premaxilla in an infant with a bilateral cleft lip and palate (Fig. 28-18A), a straight extraoral force would not place the premaxilla in the facial midline. Therefore the premaxilla must be positioned in the midline before premaxillary retraction. In this clinical presentation, an impression is made of the infant's premaxilla for construction of an external acrylic "bulb" prosthesis. This appliance is fitted over the protruding and laterally displaced premaxilla and anchored to the infant's head with a bonnet appliance (see Fig. 28-18B). By the application of sequentially increasing differential forces to the premaxilla with elastic straps attached to the bulb prosthesis, the premaxilla is brought into the facial midline (see Fig. 28-18C). Depending on parental compliance with therapy (the appliance should be in place 24 hours a day), the laterally displaced premaxilla can be repositioned to the facial midline in 3 to 4 weeks. After the premaxilla is in the midline, the bulb appliance is replaced by a

single elastic strap (see Fig. 28-18D). Over the next 1 to 2 months, equal pressure is applied on the still protruding premaxilla to retroposition it into a more normal position between the lateral segments (see Figs. 28-18E and F).

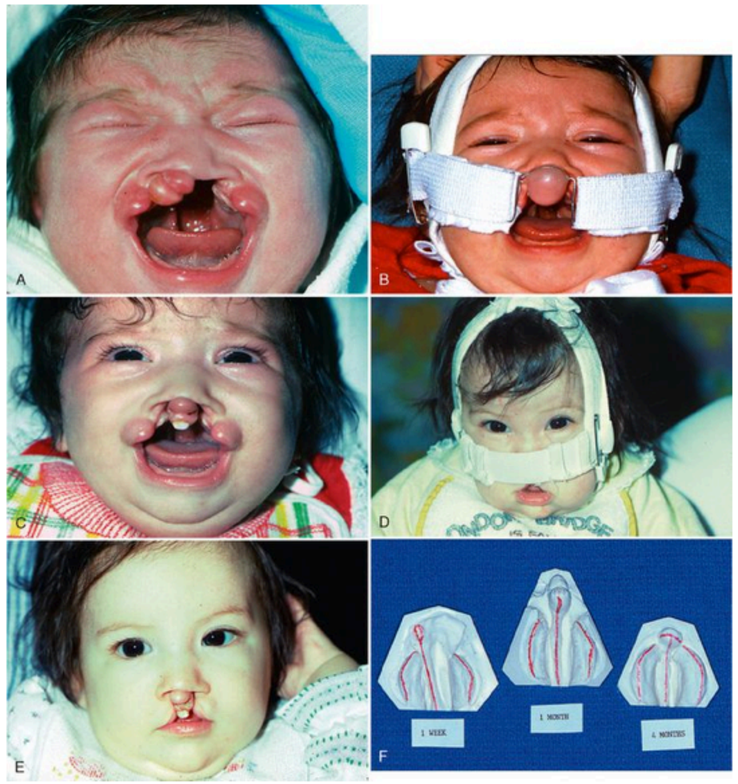


Figure 28-18 A, A bilateral complete cleft of the lip and palate in a newborn infant. Notice the severely anteriorly protruded and laterally deviated premaxillary segment. **B,** Placement of "bulb" prosthesis over the premaxillary segment; bulb is anchored to the bonnet. **C,** Patient at the end of bulb therapy to position the laterally deviated premaxillary segment to the facial midline. **D,** Strap therapy to improve the anteroposterior relationship of the protruding premaxillary segment before definitive lip closure. **E,** Premaxillary segment at the completion of strap therapy. Notice the improvement in position (compare with A) at this time. **F,** Sequential models at 1 week (initial presentation), 1 month (completion of bulb therapy), and 4 months (completion of strap therapy). Notice the improving position of the premaxillary segment at these various times.

*(**D** and **F** from Jones JE, et al. Three dimensional premaxillary orthopedic technique for improved position and symmetry prior to cheiloplasty in bilateral cleft lip and palate patients, Quintessence Int 16:229–231, 1985.)*

The rationale for use of a bulb prosthesis before elastic strap retraction includes the following considerations:

1. The bulb prosthesis affords greater control over the differential forces applied to the premaxilla.

2. Movement of the premaxilla into the facial midline before retropositioning (rather than into a laterally deviated position) decreases the risk of distorting a vomer stalk.

3. The need for a surgical premaxillary setback (a procedure known to be associated with possible growth attenuation and other complications) is eliminated.

4. Optimum premaxillary positioning may eliminate the need for a staged lip closure (adhesions before definitive lip repair) and thereby decrease total hospitalization time and cost.

5. The appearance of the nose and lip is improved because the lip can be surgically closed under less tension and the alveolar segments have an underlying symmetric alignment.

Airway Obstruction

Infants with airway obstruction secondary to Pierre Robin sequence (micrognathia, glossoptosis, and cleft palate) may require intervention to aid breathing (Fig. 28-19A). An obturator with a posterior palatal extension should be used to reposition the tongue downward and forward out of the cleft site (see Fig. 28-19B). If a nonsurgical approach is unsuccessful, lip-to-tongue adhesion (thus positioning the tongue anteriorly and opening the oral airway) or tracheostomy may be necessary.

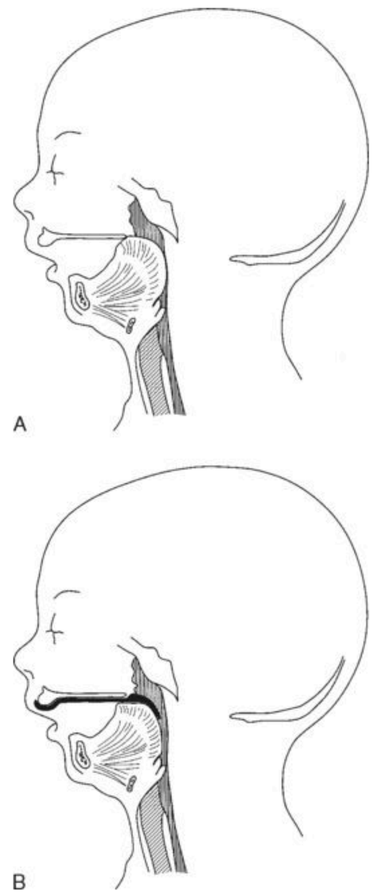


Figure 28-19 A, Infant with airway obstruction secondary to Pierre Robin sequence. Notice the closure of the oral airway related to the retroposition of the tongue. **B,** Infant with obturator in position. Notice the anterior placement of the tongue, which allows the oral airway to remain open.

Cheiloplasty

The appearance of an unrepaired wide cleft lip can be distressing. Some parents feel anxiety, depression, guilt, or rejection. Lip surgery will significantly improve the infant's appearance and may thereby relieve parental apprehensions and enhance acceptance.

Surgical closure of the cleft lip may be accomplished shortly

after birth. However, most surgeons defer closure to allow the infant to be followed by the primary care physician, who assesses early growth and development and rules out the presence of any other congenital anomaly. Surgical closure is usually accomplished at 10 weeks of age. At the time of lip closure, when the infant is under general anesthesia, an impression is made of the maxillary arch for construction of a new obturator. This is necessary to accommodate craniofacial growth during the first few months of life.

Maxillary Orthopedics (3 to 9 Months)

After definitive lip closure at about 3 months of age, maxillary arch collapse in unilateral or bilateral complete cleft is common. It is attributed to the increased tension placed on the segments by the repaired lip. To prevent this collapse, the obturator is used to provide cross-arch stability and support. As pressure is exerted on the anterior segments of the maxilla by the repaired lip, orthopedic molding of the segments can be achieved. In unilateral cases, the force applied to the greater segment by the intact lip molds that segment around to approximate the lesser segment (Fig. 28-20). This molding is facilitated by the obturator, which provides a fulcrum around which the anterior portion of the greater segment rotates. At the same time the appliance resists any tendency for the greater and lesser segments to collapse toward the midline. In bilateral cleft cases, the repaired lip provides further retraction at the premaxilla, positioning it between the two lateral maxillary segments. When the maxillary segments are in good alignment and abutted across the cleft sites, the patient is ready for the primary cleft bone graft. This generally occurs by 6 to 9 months of age.

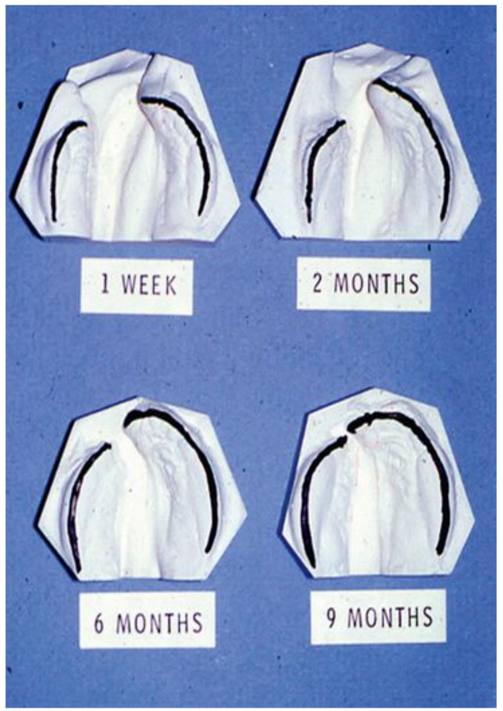


Figure 28-20 Sequential maxillary arch dental models demonstrating maxillary orthopedic molding in an infant with a unilateral complete cleft of the lip and palate. Notice that, as the cleft defect closes with time, lateral arch dimension is maintained, which produces optimal maxillary arch symmetry.

(From Jones JE, et al. Maxillary arch expansion in cleft lip and palate infants prior to primary autogenous alveolar bone graft surgery, Quintessence Int 17:245-248, 1986.)

Bone Grafting of Alveolar Cleft Defects

Bone grafting of alveolar cleft defects has been a confusing issue to many patients and practitioners. This stems in part from the lack of unanimity concerning terminology and technique. The following definitions, which have been reasonably accepted by practitioners, will be used in this discussion.

Primary bone grafting refers to bone-grafting procedures involving alveolar cleft defects in children younger than 2 years of age; this term implies nothing about technique. Early secondary bone grafting refers to bone-grafting procedures performed between 2 and 4 years of age. *Secondary bone grafting* is done between 4 and 15 years of age, and *late secondary bone grafting* refers to reconstruction of residual alveolar cleft defects in the adult.

Primary Alveolar Cleft Bone Grafting

Primary alveolar cleft bone grafting is controversial. The concept fell into disfavor in the early 1970s amid numerous reports of significant attenuation in midfacial growth. Robertson and Jolleys used an orthodontic appliance for the first 3 months of life when the lip, anterior palate, and soft palate were closed.[9]

A retention device was then fitted until closure of the hard palate at 11 months. Primary bone grafting was carried out at 12 to 15 months when bone was inserted with little dissection through a horizontal incision in the buccal sulcus. After a 5-year follow-up, the authors noted that patients in the grafted group showed a clear deterioration of the dental-base relationship and development of pseudoprognathism, whereas among those in the nongrafted group the dental-base relationship remained stable. Limitation of growth occurred in the maxillae of the grafted patients and was manifested by reduced anteroposterior development, an increased incidence of crossbite, and a reduced area of the upper jaw. These authors, as well as others, recommended that bone grafting in young patients be abandoned.

These negative reports led to nearly universal cessation of primary alveolar cleft bone grafting on the basis that the procedure, performed at such an early age, significantly attenuates maxillary and midface growth. However, certain interesting facts emerge when these reports are carefully analyzed. None of the reporting groups used the same surgical technique. Although the techniques may appear similar at first glance, there are differences that make each approach unique. Therein lies a problem with the categorical statement that primary cleft bone grafting should be abandoned because it impedes maxillary and midfacial growth. What is primary cleft bone grafting? How broad is its definition? As discussed earlier, the term primary cleft bone grafting implies nothing about technique, only timing. The term is applied to any cleft bone grafting technique used between birth and 2 years of age. Because the techniques vary, sweeping statements that condemn or condone primary cleft bone grafting should be viewed with suspicion. Each

technique should be judged on its merits, without any bias traceable to the popular view that primary cleft bone grafting retards maxillary and midfacial growth.

Many of the negative reports have used techniques involving extensive dissection in areas adjacent to and including the vomeropremaxillary suture. Friede reported that surgery in the area of the vomeropremaxillary suture may lead to impaired maxillary and midfacial growth in individuals with unilateral and bilateral clefts.[10] He stated that techniques that disturb the vomeropremaxillary suture would never have been introduced if surgeons had realized the significant role that this suture apparently plays in the postnatal growth of the face in the cleft patient.

For more than 40 years, although primary cleft bone grafting has been generally held in disfavor, one group in particular, Rosenstein and colleagues, has championed the cause of primary cleft bone grafting. As might be expected, their technique differs significantly from the others used. In their approach, a newborn with a cleft was fitted with a maxillary orthopedic appliance. The lip was repaired at approximately 6 weeks of age. Through the orthopedic appliance and pressure of the repaired lip on the alveolus, the maxillary segments were molded into alignment so that the segments abutted across the cleft site. Premaxillary orthopedics was used as necessary with a bilateral cleft to position the premaxilla before lip closure. With the segments well aligned, a minimal dissection technique was used at 6 to 9 months of age to develop a pocket at the level of the alveolus across the cleft site (Fig. 28-21). A 2-cm segment of rib was harvested and split longitudinally. Half was inserted into the pocket in an on-laid fashion over the alveolus, bridging the cleft. Palatoplasty (surgical closure of the palate) was typically completed at 1 year of age.

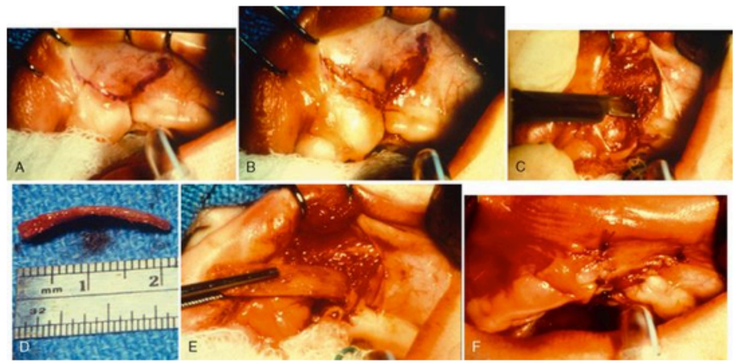


Figure 28-21 A composite of pictures illustrating the primary alveolar cleft bone graft technique. **A,** Abutted maxillary segments with initial incisions outlined. **B,** Development of a small mucosal flap from the lip that will be used to cover the labial surface of the graft. **C,** The development of the subperiosteal pockets on the labial aspect of the alveolus. **D,** Section of rib that has been split longitudinally and contoured slightly to conform to the curvature of the maxillary anterior alveolus. **E,** Insertion of the rib segment into the labial pockets. **F,** Tissue closure over the graft.

Preliminary results were encouraging, and in 1982 Rosenstein and colleagues reported on a series of 32 patients who were followed up for up to 15 years.[11] They found no significant attenuation of maxillary or midfacial growth in patients who had received primary cleft bone grafts compared with cleft patients who had received no grafts. In 1991, they reported on another 37 patients (20 with unilateral and 17 with bilateral clefts) and reached the same conclusions.[12] In 2003, they described an additional 82 cases and reported on secondary surgical need and the status of teeth adjacent to the cleft.[13] The authors stated that the growth in their sample was as good as that in other similar samples that did not receive the primary bone grafting. In addition, the authors reported the incidence of orthognathic surgery to be 18.29%; of pharyngoplasty, 3.65%; and of surgical closure of oronasal fistulas, 29.27%. In cases of unilateral complete clefts, 53.13% of the lateral incisors present adjacent to the cleft area were usable, and in bilateral cases, 57.77% were usable.

The apparent success of their technique can be attributed to the following departures from previous methods:

1. Lip repair was separated from bone grafting.

2. The bone graft was inserted only when the two halves of the maxilla abutted in the alveolar region where there was no great gap to bridge.

3. The limited dissection was carried out only on the anterior surface of the maxilla and alveolus, with no dissection performed in the area of the vomeropremaxillary suture.

Experience demonstrated that in nongrafted clefts, maxillary arch collapse was common after palatoplasty in unilateral and bilateral cases. When the palate was repaired, pulling the tissue together in the midline created transpalatal forces that moved the lesser segment or, in the case of bilateral clefts, the lateral maxillary segments toward the midline. This often resulted in a maxillary arch form that led to crossbite situations and compromised masticatory function. These problems were not always easily correctable. Reestablishing a reasonable arch form through orthodontic and surgical means presented a challenge because scar tissue that had formed across the palate often prevented desired segmental movement. If segmental movements could be accomplished, it was often at the expense of soft tissue form and function. Palatal fistulas frequently persisted or reopened. Periodontal compromises because of stretching of tissue were common. Primary grafting establishes maxillary arch continuity early in life by producing a one-piece maxilla rather than two or three segments (Figs. 28-22 and 28-23) and thus facilitates future treatment. Often these patients can be treated like any conventional orthodontic patient. In many instances, primary lateral incisors erupt into and through the graft.

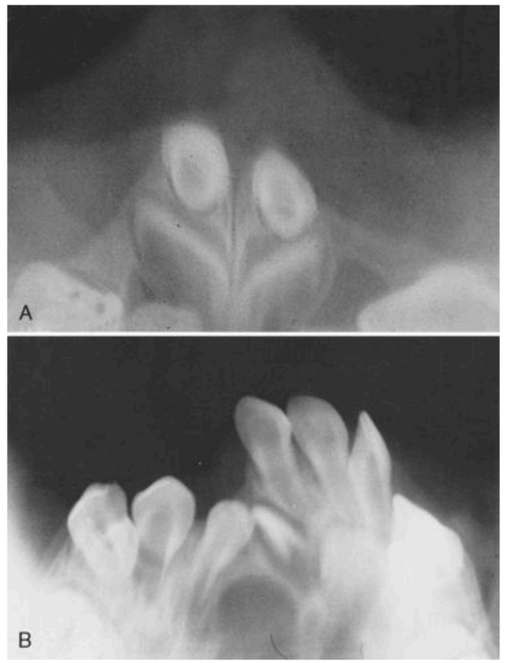


Figure 28-22 A, Radiograph of bilateral complete cleft of the lip and palate after primary alveolar cleft bone graft. Notice the grafted bone bridging the cleft sites, which provides stabilization of the premaxillary segment. **B,** Radiograph of unilateral complete cleft of the lip and palate after primary alveolar cleft bone graft. Notice the grafted bone bridging the cleft site and the migration of the primary lateral incisor through the graft.

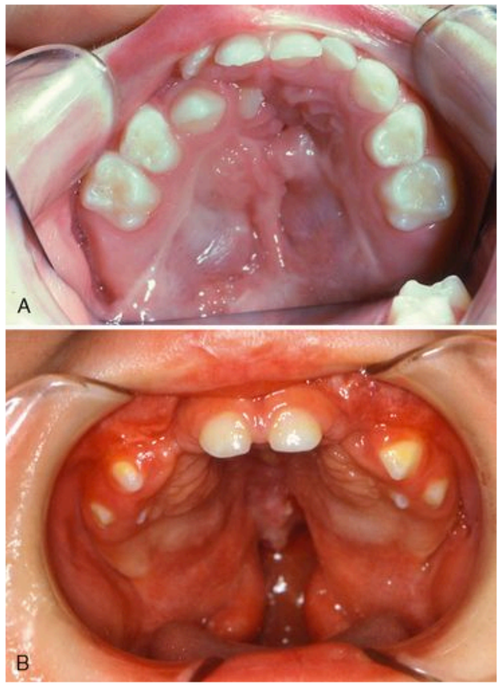


Figure 28-23 A, Intraoral view of a unilateral complete cleft of the lip and palate after primary alveolar cleft bone graft. **B,** Intraoral view of a bilateral complete cleft of the lip and palate after primary alveolar cleft bone graft. Because the premaxillary segment is fixed to the lateral maxillary segments, the arch form is expected to remain in good relationship.

Use of a primary alveolar cleft bone graft does not necessarily preclude the later accomplishment of a secondary alveolar cleft bone graft if it is indicated. The objectives of a secondary cleft bone graft can be somewhat different, as will be seen. Although a recent survey of cleft and craniofacial teams of the American Cleft Palate–Craniofacial Association reported that only 3% of teams perform primary alveolar cleft bone grafting, in our experience it provides excellent results. Continued critical evaluation of our results is being accomplished to document the benefits of the procedure.

A different approach to normalizing the cleft alveolar segment relationships has been advocated by Huebener and Marsh.[14] In their treatment protocol, which uses the forces created by either lip adhesion or primary lip closure, a passive alveolar molding appliance similar to that used by Rosenstein is employed.[15] The passive appliance does not have an acrylic extension over the alveolar ridges and it is placed on the day of the lip surgery. The tension created by lip closure acts over time on the anterior alveolar cleft segments (in both unilateral and bilateral cleft) and shapes these cleft segments around the anterior portion of the molding appliance. The appliance is worn by the infant until palatoplasty. Usually at that time the cleft segments are abutting and the torqued maxillary frenum has returned to the midsagittal plane. In this protocol, no primary alveolar bone grafting is performed.

Some researchers have recommended the use of active appliances for the normalization of the infant cleft alveolar segments before initial lip surgery. Latham and colleagues use a dentomaxillary advancement appliance to bring unilateral cleft segments into approximation.[16] In bilateral clefts, they expand collapsed lateral cleft segments and actively retract the premaxilla into a more ideal arch form. They postulate that such presurgical maxillary orthopedic procedures make lip surgery easier and result in less soft tissue tension following closure.

More recently, Grayson and Cutting have promoted the use of a nasoalveolar molding (NAM) appliance with a nasal labial extension to shape the nasal cleft cartilage.[17] The objective of this presurgical effort is to reduce the severity of the cleft deformity, approximate the alveolar and lip segments, decrease the nasal base width, and attempt to achieve symmetry of the nasal cartilages. (Fig. 28-24). They indicate that if these treatment objectives are achieved, the esthetic and functional outcome of the primary lip and nose surgery should be more favorable. In addition, an additional presurgical treatment objective in bilateral cleft patients is columella lengthening. With the use of bilateral nasal stints and taping techniques, the almost absent columella in bilateral clefts can be nonsurgically elongated before initial lip and nose surgery.

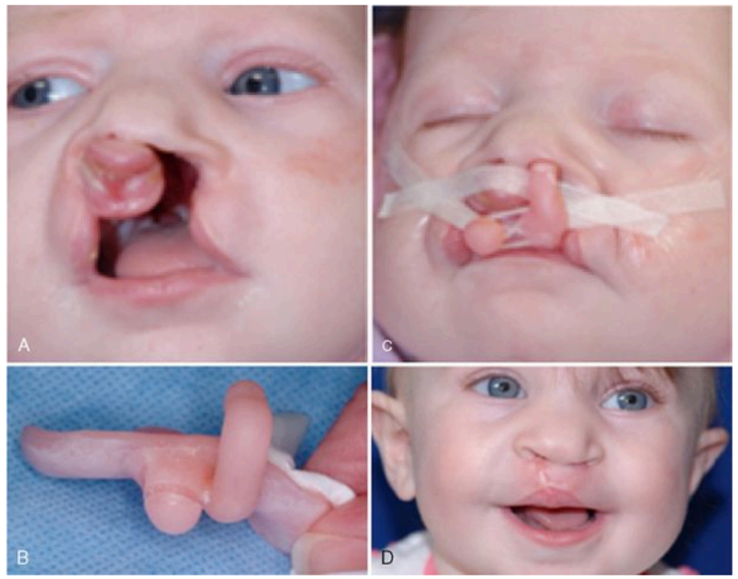


Figure 28-24 A, A 6-week-old infant with a bilateral cleft lip and palate. There is complete bilateral clefting of the palate, an incomplete cleft lip on the right side, and complete cleft lip on the left side. The premaxilla is displaced anteriorly and to the right side. **B,** A nasoalveolar molding (NAM) that has a left nasal extension designed to give better shaping to the left nares. The acrylic portion that fits over the palate and premaxilla is designed to bring the premaxilla to center, and back into alignment with the right and left alveolar segments. This is accomplished with selective addition and removal of acrylic. **C,** The infant with the NAM appliance in place and active at almost 3 months of age. **D,** The infant at post lip repair. The premaxilla has been brought into good arch alignment with the alveolar segments.

(Photos courtesy of Jennifer Kugar, DDS, MSD, James Whitcomb Riley Hospital for Children, Craniofacial Anomaly Team.)

Palatoplasty

Closure of the palate is accomplished between 12 months and 2 years of age. The primary purpose of completing palate closure by 2 years of age is to facilitate the acquisition of normal speech, because this correlates with the age at which most children begin to talk. The procedure may also improve hearing and swallowing by aligning the cleft palatal musculature.

After primary closure of the cleft palate, approximately 25% of patients demonstrate some velopharyngeal insufficiency. A persistent inability to close the nasopharynx may result in unsatisfactory speech (nasality and articulation problems), regurgitation of fluids from the nose, and facial grimacing. Of the various surgical approaches to correct velopharyngeal insufficiency, the pharyngeal flap is most commonly used at Indiana University. The procedure is generally performed when velopharyngeal insufficiency is documented in an attempt to normalize the speech of the child before he or she begins school.

One of the most important aspects of stage I is the beginning of infant oral health care. It is during this time that the American Academy of Pediatric Dentistry advocates the "age one" dental visit.[18] During this visit, the pediatric dentist examines the oral cavity, notes any abnormalities in the soft and hard tissues, and provides anticipatory guidance to the parents regarding oral health care. Also during this visit emphasis is placed on the prevention of oral disease. In particular, this first visit offers parents an opportunity to discuss the many developmental issues unique to the cleft deformity. The pediatric dentist explains the role of each specialist on the cleft team and outlines the treatment benchmarks to be accomplished for their child during specific intervals.

STAGE II (PRIMARY DENTITION STAGE: 18 MONTHS TO 5 YEARS OF AGE)

Treatment during the primary dentition stage of dental development is initially focused on establishing and maintaining oral health. Meticulous daily oral hygiene for the child, with emphasis on direct assistance from the parents, is established to reduce the possibility of development of dental caries. Ectopic eruption of the primary maxillary anterior dentition is common around the cleft defect.

Special care should be taken to keep these teeth free from caries because food often is lodged in and around the cleft defect. An increase in the frequency of periodic recall examinations, possibly to 3- to 4-month intervals, enables the dentist to intercept areas of decalcification. This preventive regimen is continued throughout all subsequent stages in the management of the cleft.

In some extensive cases of unilateral and bilateral complete clefts of the lip and palate, surgical closure is postponed beyond the usual 18 to 24 months of age. In these cases, because of the development of speech at this age, maxillary prosthetic appliances are constructed to provide normal maxillary arch integrity (Fig. 28-25). As the child grows, more tissue will become available to close the palate when doing so is surgically appropriate.

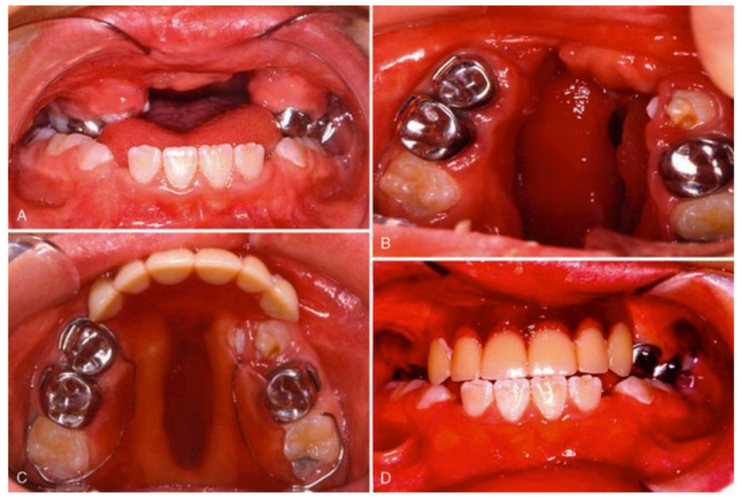


Figure 28-25 A, Intraoral view of a unilateral complete cleft of the lip and palate. Because of the extensive cleft of the hard and soft palate, the treatment of choice was prosthodontic obturation of the defect until growth was sufficient to allow definitive surgical closure. **B,** Maxillary arch demonstrating extensive cleft of the palate requiring an interim prosthesis. **C,** Interim maxillary prosthesis in place. This effectively closes the oral from the nasal cavities and facilitates mastication and speech. The appliance is removed daily for cleaning. **D,** Interim prosthesis in occlusion. The prosthetic anterior teeth provide support of the upper lip and improves esthetics.

STAGE III (LATE PRIMARY OR MIXED DENTITION STAGE: 6 TO 10 OR 11 YEARS OF AGE)

Many problems encountered during the late primary and mixed dentition stage of dental development arise from ectopically erupting permanent central and lateral incisors or crossbites of the posterior dental segments. Treatment therefore concentrates on correction of a developing traumatic occlusion and posterior segmental alignment. Interceptive correction of a traumatic

occlusion is essential to prevent destruction of enamel in the involved dentition (Fig. 28-26). Maxillary expansion to correct posterior segmental collapse is accomplished by routine palatal expansion (Fig. 28-27). This is especially important in patients who have not undergone primary alveolar cleft bone grafting. Once the condition is corrected, retention can be maintained by passive holding appliances.

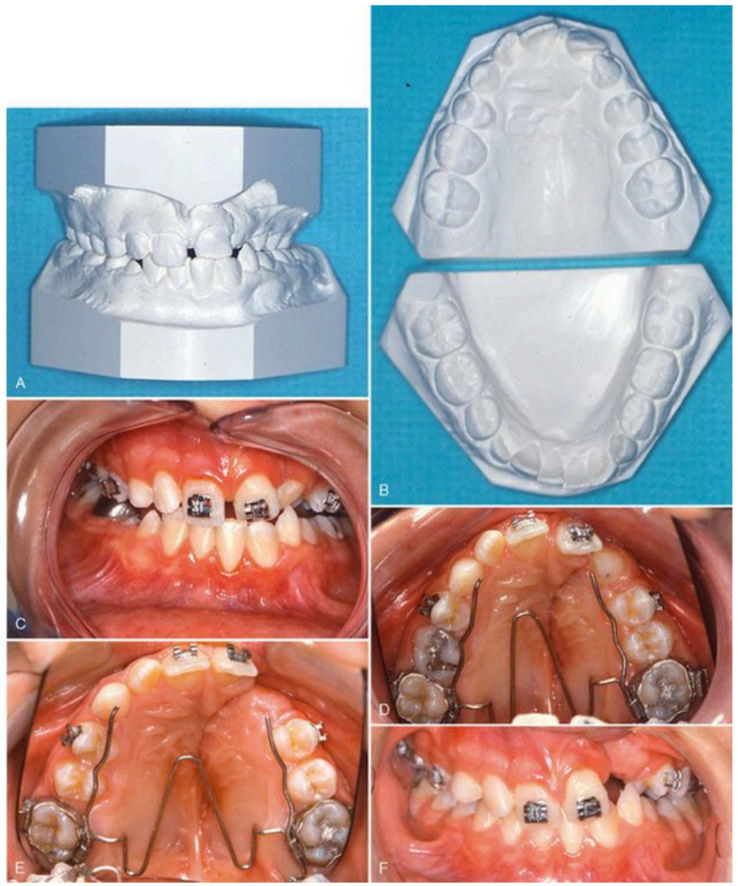


Figure 28-26 Interceptive correction, in the mixed dentition, of a full maxillary left crossbite in a complete unilateral cleft of the lip and palate. **A,** Diagnostic models for a unilateral complete cleft of the lip and palate. Notice the presence of a crossbite extending from the maxillary left central incisor to the maxillary first permanent molar. **B,** Occlusal views of maxillary and mandibular models. Notice the pronounced asymmetry of the maxillary arch. **C,** Occlusion with fixed appliances in place on the maxillary arch. **D,** Occlusal view demonstrating removable W arch to correct the posterior segmental crossbite. **E,** Occlusal view demonstrating correction of posterior crossbite and improved alignment of the maxillary anterior segment. Notice the improved maxillary arch symmetry. **F,** Occlusion at the end of interceptive therapy. Notice the correction of the anterior and posterior crossbites. At this time, the patient is ready for secondary alveolar bone grafting (see text for description of secondary bone-grafting procedure).

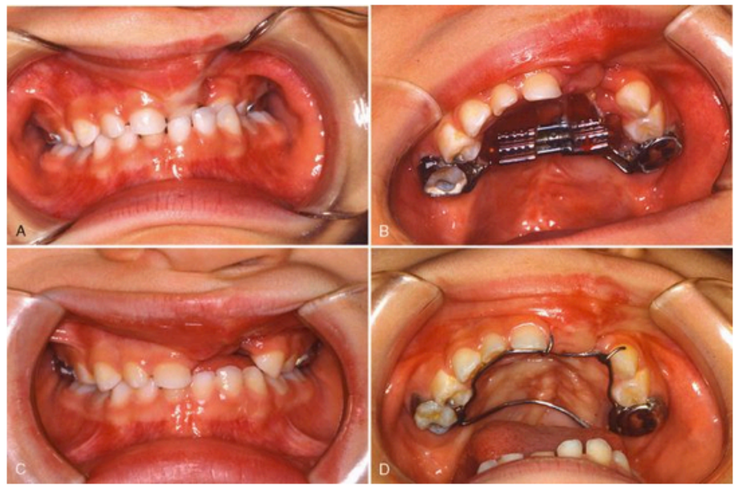
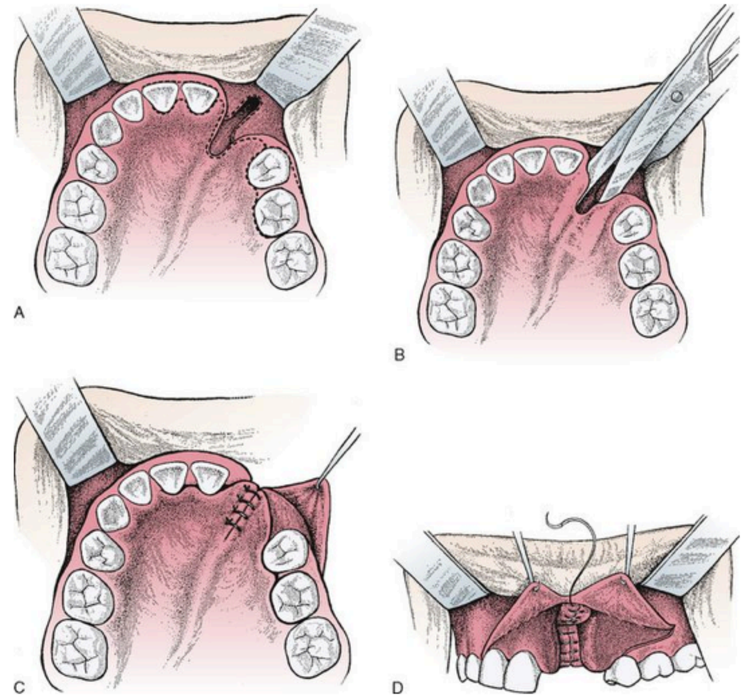


Figure 28-27 Interceptive correction, in the primary dentition, of a full maxillary left crossbite in a complete unilateral cleft of the lip and palate. **A,** Occlusion demonstrating a crossbite from the maxillary left primary incisor extending to the second primary molar. **B,** Fixed palatal expander in place on the maxillary arch at the completion of expansion. The left primary central incisor, loosened by traumatic occlusion before initiation of therapy, exfoliated during treatment. **C,** Occlusion at the completion of interceptive therapy. Notice the correction of the posterior crossbite. **D,** Placement of a passive maxillary arch-holding appliance to maintain optimal arch symmetry until the time of secondary alveolar bone grafting.

Secondary Alveolar Cleft Bone Graft

A successful alveolar cleft bone graft satisfies several objectives. In addition to giving bony support for the teeth adjacent to the cleft and providing bone through which teeth can erupt, it offers maxillary arch continuity and aids in closure of the oronasal fistula. It also supports the alar base of the nose.

Conceptually the technique is not difficult, but technically it can be tedious. There are several approaches to developing the required soft tissue flaps, but all seem to be variations of the technique described by Boyne and Sands.[19] The soft tissue in and adjacent to the cleft side is incised and elevated so that labial and palatal mucosal leaflets are everted to obtain labial and palatal closure. The tissues lining the cleft are elevated and inverted into the nose for nasal floor closure. Particulate marrow and cancellous bone harvested from the iliac crest is placed into the cleft defect, filling it from the piriform rim to the alveolar crest before closure of the labial tissues (Fig. 28-28).



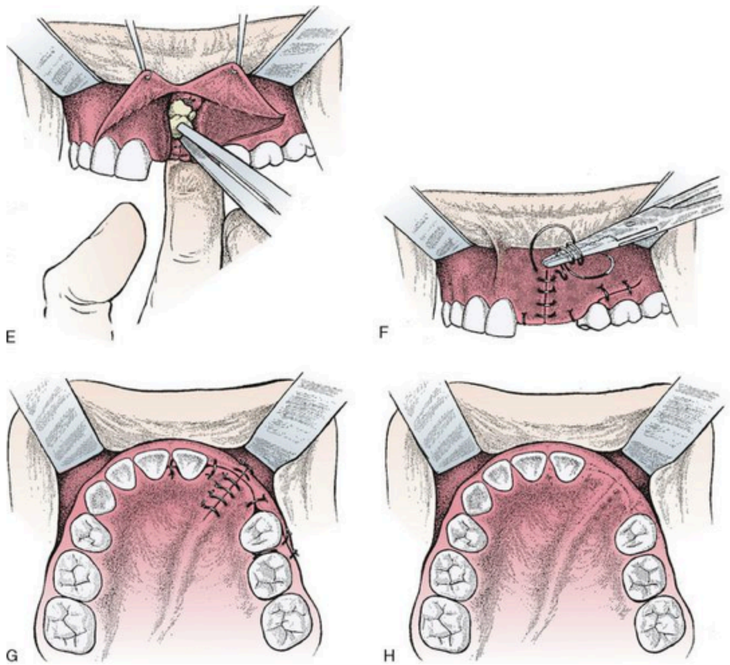


Figure 28-28 Technique for secondary alveolar cleft bone graft. **A,** Mucosal incisions outlined. **B,** Development of palatal mucoperiosteal flap. **C,** Closure of palatal mucosa. **D,** Closure of nasal mucosa within cleft site. **E,** Placement of fresh autogenous bone into the cleft defect. **F** and **G,** Reapproximation and closure of mucoperiosteal flaps. **H,** The reconstructed maxillary alveolus.

Providing bony support to teeth adjacent to the cleft site is of paramount importance (Fig. 28-29). In most cases, bone should be grafted into the cleft before orthodontic tooth alignment is begun. When the cleft is filled with normal, viable bone, the orthodontist can proceed with tooth alignment without fear of exposing a root surface into the cleft site. In fact, after a 2-month healing period, a tooth can be moved into the newly grafted bone with the expectation that the bone will respond to the tooth movement as any normal bone would. Any tooth movement undertaken before the graft is placed could jeopardize the bony support of the teeth adjacent to the cleft.

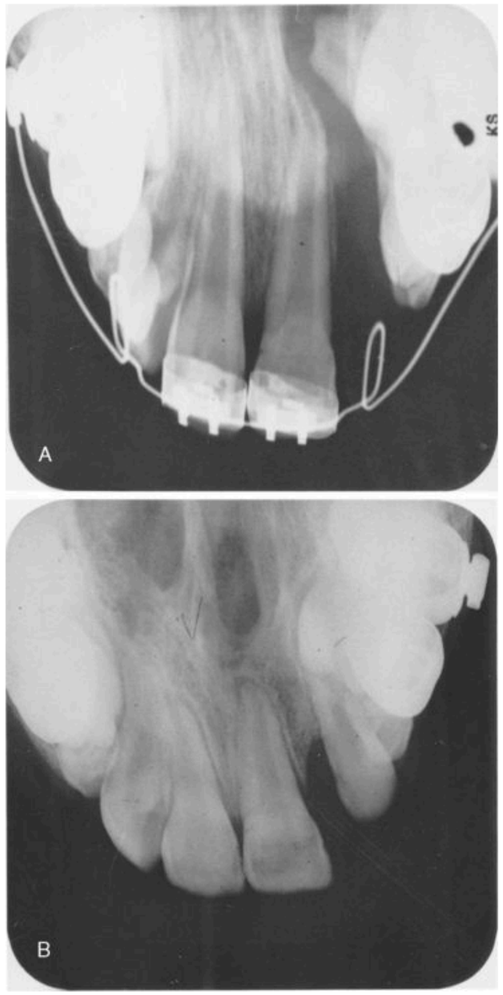


Figure 28-29 A, Pregraft maxillary occlusal radiograph demonstrating cleft defect with thin layer of bone over the distal root surface of the maxillary left central incisor. The canine has not started to erupt at this time. **B,** Postgraft maxillary occlusal radiograph demonstrating consolidation of bone across the cleft defect. Preliminary orthodontic alignment has been completed. The canine can be expected to erupt through the grafted area.

(From Nelson CL, et al. Indiana's craniofacial anomalies team: Dentists play an important role, J Indiana Dent Assoc 65[6]:9-13, 1986.))

As a related consideration, grafted bone that obliterates the alveolar cleft also provides bone through which teeth can erupt. When canines and, in some cases, central incisors are allowed to erupt before bone grafting, they often lack adequate periodontal bone support. When the bone graft precedes permanent tooth eruption, compromised periodontal situations can often be prevented. El Deeb and colleagues studied the eruption patterns of canines through grafted bone in alveolar cleft defects.[20] They found that canine teeth erupt spontaneously through the grafted bone but that this eruption may be later than normal and that it takes longer. In their study, 27% of the canines erupted spontaneously. The remainder required surgical uncovering and orthodontic forces to accomplish eruption and alignment in the arch. Turvey and associates found the rate of spontaneous eruption to be 95%, which represents a significant difference.[21] However, the point is that canines can and do erupt through the grafts. If eruption seems greatly delayed, surgical and orthodontic intervention is appropriate.

El Deeb and colleagues have recommended that the graft be placed between 9 and 12 years of age when the canine root is one quarter to half formed.[20] They reported that the canine subsequently has normal root development and that morphologic conditions will be unaffected by the surgical procedure.

Restoring maxillary arch continuity and stabilizing the maxillary segments represent other major objectives. In the bilateral cleft case, the premaxilla is stabilized as the bone grafts are incorporated between the premaxilla and the lateral maxillary segments. In the process, the alveolar ridge contour is restored so that the ability to provide a stable, esthetic prosthesis is enhanced. There is often some degree of collapse of the maxillary arch form. It is possible to expand the arch after grafting, as pointed out by Boyne and Sands[22]; however, it is preferable to expand these collapsed segments to as optimal an arch form as possible before grafting. Pregraft expansion also widens the cleft site, which allows better access for nasal floor closure. After the arch expansion has occurred, the bone graft can be placed. After the graft has been incorporated, it can be expected to maintain a good arch form.

Closure of the oronasal fistula is often the most significant result of bone graft surgery, according to patients. They often have fluid

regurgitation into the nose and mucus drainage from the nose into the oral cavity through the fistula. Depending on its size, the fistula can produce significant speech problems because air escapes when the patient phonates. Although closure of this fistula can be effected with only soft tissue closure, Enemark and associates have indicated that closure is more successful when combined with a bone graft.[23]

With a cleft maxilla the cleft extends through the piriform rim beneath the alar base of the nose. As a result, the alar base on the cleft side is often depressed because of lack of underlying bony support. Filling the cleft with bone provides underlying bony support that often elevates the alar base of the nose. Although this may not entirely correct any existing nasal deformity, it does provide good support over which nasal reconstructive and revision surgery can be accomplished.

Secondary alveolar cleft bone grafting has been widely accepted. According to several researchers,[19,24-28] success rates are generally in the 90% range. Morbidity has included pain in the donor site, dehiscence of mucosal flaps, and partial or complete loss of grafted bone. Infection in the donor or recipient sites has been rare. An unpublished survey by Huebener indicated that secondary alveolar bone grafting (grafting performed in the mixed dentition) is routinely performed by all teams.

Secondary alveolar cleft bone grafting is an important procedure that greatly facilitates total habilitation. Not only is speech improved but dental, esthetic, and psychosocial benefits are to be gained. It is necessary again to emphasize the different objectives of primary and secondary grafting and to reiterate that they are not mutually exclusive procedures. The primary graft, over time, may satisfy some or all the objectives of secondary grafting. However, to the extent that it does not, augmenting the primary graft with particulate marrow and cancellous bone from the iliac crest may be recommended as a secondary procedure.

Effect of Facial Esthetics on Self-Concept

Appearance helps determine how an individual interacts with society and, in turn, how society perceives and accepts that individual. Facial esthetics is especially important to the development of self-concept. A child born with a serious congenital facial anomaly may find adaptation difficult. For example, Striker and associates have stated that the psychological sequelae of cleft lip and palate may have as great an impact on the individual as the physical aspects.[29] MacGregor stressed that, because of society's emphasis on physical attractiveness and conformity, the role of the face in interactions with others is such that many problems associated with cleft lip and palate involve considerations of mental health.[30]

Of special importance in the comprehensive dental management of cleft lip and palate is the dentist's ability to provide the young patient with interim prostheses to improve facial appearance (Fig. 28-30). These can be periodically adjusted to allow eruption of the developing dentition. Such treatment, when possible, should begin before the child starts formal education.

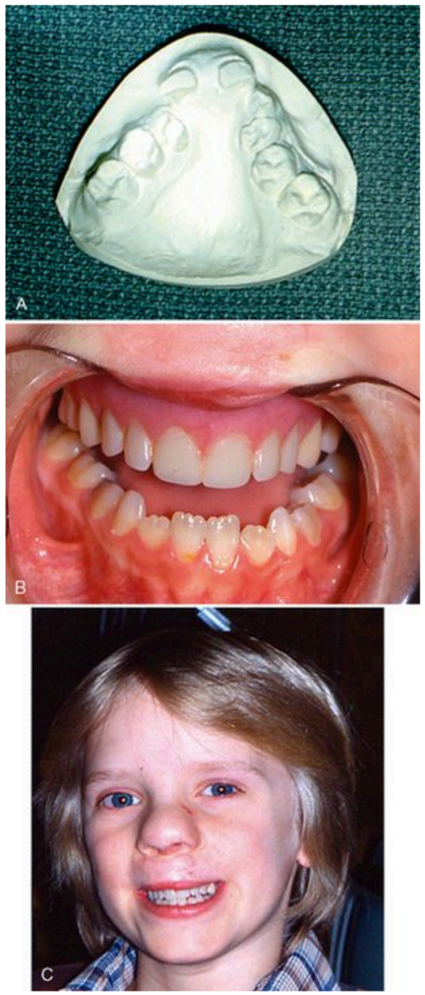


Figure 28-30 **A**, Plaster model of patient's maxillary arch ready for construction of the interim denture. **B,** Transitional maxillary complete overdenture. Such appliances may be used several years without replacement. **C,** Transitional maxillary overdenture in place. The patient's selfesteem is greatly enhanced by his essentially normal facial esthetics.

STAGE IV (PERMANENT DENTITION STAGE: 12 TO 18 YEARS OF AGE)

The majority of persons with cleft lips and palates require some degree of orthodontic management and can be treated in a conventional manner. Some cleft patients, however, will require a combined orthodontic-surgical approach in the permanent dentition to achieve optimal outcome. Before initiating the indicated therapy, the orthodontist completes a full diagnostic examination to determine the status of the patient's craniofacial development.

Most orthognathic surgical procedures involving the maxilla and mandible are deferred until the teenage years, when maximum growth of the jaws has been attained and all permanent teeth except the third molars have erupted. In boys, surgeons usually delay osteotomies until approximately 17 to 18 years of age; in girls, because of earlier maturation, surgery sometime after 15 years of age is possible. The manner in which the maxilla and mandible relate to each other spatially after growth is frequently difficult to predict based on the patient's appearance as a child. An example is the patient with a complete bilateral cleft lip and palate who has a protuberant premaxilla at birth. In childhood, the lateral profile may appear severely convex, and the initial impression is that the patient will require a premaxillary segment surgical setback. This could be an erroneous assumption, and corrective surgery could be potentially deleterious if it is performed at an early age. With time, many of these persons acquire an essentially normal lateral facial profile. By the time maximum growth has been attained, a surprising number of these persons acquire a more normal convex profile.

In some instances, children with a cleft with a severely retrusive maxilla cannot undergo orthodontic correction with conventional therapy. In these cases the surgical procedure often used is the LeFort I maxillary advancement. This procedure is not technically feasible until the patient has a full complement of permanent dentition. The horizontal cuts to free the maxilla must necessarily be

made above the apexes of the permanent dentition. Unerupted cuspids or bicuspids would make this procedure impractical. Therefore surgery must be deferred until the permanent dentition has erupted.

Cosmetic Surgery

Major nasal bone surgery may be deferred until the patient is in the early teens. However, cartilaginous nasal tip asymmetries may be corrected at any time. Additional tip-cartilage revisions may be performed as needed.

Common secondary deformities of the repaired unilateral or bilateral cleft lip include an upper lip that is too long or short, a tight upper lip, a deficiency of the vermilion tissue, and residual clefts (or notching) of the lip. Accurate predictions of how such deformities will manifest themselves are impossible until growth of the tissues is complete. Consequently, final surgical revision is frequently deferred until the mid to late teens. It is also prudent to defer final lip revisions until any surgical or orthodontic treatment that will change the osseous or dental support of the upper lip is complete.

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