Orthognathic Surgery for the Cleft Lip and Palate Patient

Jeffrey C. Posnick

A thoughtful staged reconstruction for the cleft lip and palate patient is the preferred approach. The primary lip and palate repair performed during infancy and early childhood provides the foundation for normal speech, occlusion, facial appearance, and self-esteem. A long-term negative effect of these early surgical interventions is a significant incidence of maxillary growth restriction that produces secondary deformities of the jaws and dentition. This article reviews the variations in presentation, surgical and orthodontic techniques, and the results that we have achieved in patients born with a cleft who underwent primary repair in childhood, had a jaw deformity and malocclusion in adolescence, and underwent orthognathic surgery combined with orthodontic treatment for facial reconstruction and dental rehabilitation. (Semin Orthod 1996;2:205-214.)

The optimal management of patients with cleft lip and palate continues to challenge the health care delivery system. The primary lip and palate repair performed during infancy and early childhood provides the foundation for normal speech, occlusion, facial appearance, and self-esteem. One long-term negative effect of these early surgical interventions is a significant incidence of maxillary growth restriction that produces secondary deformities of the jaws and malocclusion, which also impacts on speech and self-esteem. Ross documented that in approximately 25% of adult males with a repaired unilateral cleft lip and palate, orthognathic surgery is necessary to permit an adequate functional relationship of the jaws and teeth. The cephalometric criteria he applied are traditional ones that are likely to underestimate the actual number of adolescents born with a cleft who would benefit from orthognathic surgery.

The prevalence and extent of residual maxillofacial deformities in the adolescent born with a cleft vary widely depending on a team philosophy about the staging of reconstruction and on available technical expertise. In addition, despite a center’s preferred method of managing cleft deformities during infancy and childhood, there will be a subgroup of patients who, in adolescence, have multiple neglected or residual cleft-related problems.

Our philosophy for management of alveolar clefts and residual perialveolar oronasal fistulas is to fill the bony defect with autogenous iliac (hip) bone graft and close all oronasal fistulas at each cleft site and throughout the palate in the mixed dentition before eruption of the permanent canine tooth. This procedure is followed by orthodontic closure of the cleft-dental gap whenever feasible. If this approach is followed successfully, the adolescent with a cleft who has maxillary hypoplasia may undergo a standard Le Fort I osteotomy for correction. Unfortunately, there remains a subgroup of adolescents with a cleft-jaw deformity who have a residually clefted and perforated (oronasal fistula) maxilla. Recognition of the unique circulation requirements of the upper jaw at the time of osteotomy has allowed us to suggest an effective one-stage approach to manage these residual deformities.
The modifications are based on the premise that safe flaps can be developed for independent repositioning of the maxillary segments according to residual deformity in the maxilla, cleft type (unilateral cleft lip and palate [UCLP], bilateral cleft lip and palate [BCLP] or isolated cleft palate [ICP]), and individual variation. (Figs 1 and 2)

This article reviews the variations in presentation, surgical techniques, and the results that we have achieved in patients born with a cleft who underwent primary repair in childhood, had a jaw deformity and malocclusion in adolescents, and underwent orthognathic surgery.11

**Patients and Methods**

**Basic Patient Data**

Between 1986 and 1992, 116 adolescents (67 males, 49 females; age range, 15 to 25 years; mean age, 18 years) born with either unilateral cleft lip and palate (n = 66), bilateral cleft lip and palate (n = 33), or isolated cleft palate (n = 17) underwent orthognathic surgery by the author (Posnick) using consistent surgical techniques. (Figs 3-6) The complications and long-term results of this work has been previously reported.11

All but one patient underwent perioperative orthodontic treatment. All were judged to be skeletally mature at the time of jaw surgery, either by serial cephalometric radiographs or by epiphyseal plate closure on hand radiograph. The clinical follow-up ranged from 1 to 7 years (mean, 40 months) at the close of the study.

The patients' primary surgeons (earlier in life) varied, as did the previous cleft-related procedures that they performed. All patients had undergone primary lip and palate repair in infancy or childhood. The number and extent of previous revisional soft-tissue lip, nasal, and palatal procedures varied greatly (from 0 to 10 procedures). Most patients had undergone additional attempts to close the residual oronasal

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**Figure 1.** Illustrations of modified Le Fort I osteotomy of a UCLP patient in two segments. (A) Illustration of direct incisions for completion of osteotomies and fistula closure. (B) Frontal view of bony skeleton before and just after fixation of Le Fort I osteotomy in two segments. The inferior turbinates have been reduced, and a submucous resection of the deviated septum has been performed. Iliac, cancellous bone graft has been placed along the nasal floor. A miniplate is placed vertically along each zygomatic buttress and piriform aperture region while a microplate is placed horizontally across the segmental osteotomy site. (C) Lateral view of maxillofacial skeleton before and just after osteotomies and fixation of modified Le Fort I osteotomy. (D) Illustration of downfractured Le Fort I in two segments after submucous resection of septum, reduction of inferior turbinate through the nasal mucosa opening, followed by water-tight nasal side closure. (E) Palatal view of bony segments before and after repositioning. (F) Illustration indicating oral-side wound closure on both labial and palatal aspects after differential segmental repositioning. (Reprinted with permission from Posnick JC. Orthognathic surgery in the cleft patient. In: Russell RC, editor, Instructional Courses, Plastic Surgery Education Foundation, vol 4. St Louis, MO: Mosby, 1991:129-157.)
Figure 2. Illustrations of modified Le Fort I osteotomy of the BCLP patient in two or three segments. (A) Illustration of the BCLP patient before and after lateral segmental osteotomies and repositioning. (B) Illustrations before and after three-part maxillary osteotomies with repositioning of the segments. (C) Illustration of incisions for modified Le Fort I in three segments. (D) Illustration of down-fractured lateral segments showing exposure for nasal side closure of oronasal fistula and additional view of oral mucosa incisions. (E) Illustration of premaxillary osteotomy from palate side using either a chisel, rongeur, or reciprocating saw. (F) Illustration of oral wounds sutured at the end of the procedure. (G) Palatal view of bony segments before and after repositioning for closure of cleft-dental gaps. (Reprinted with permission from Posnick JC. Orthognathic surgery in the cleft patient. In, Russell RC, editor. Instructional Courses, Plastic Surgery Education Foundation, vol 4. St Louis, MO: Mosby, 1991:129-157.)

fistula; 20 patients underwent bone grafting to fill the alveolar cleft. Seven of 66 unilateral cleft lip and palate patients had previously undergone orthognathic surgery by another surgeon.

The basic orthognathic procedure performed in each of our patients included a Le Fort I osteotomy (n = 116). Thirty-two of these patients also had undergone simultaneous sagittal split osteotomies of the mandible; 87 underwent a vertical reduction and horizontal advancement genioplasty of varying degrees.

**Operative Technique**

The operative technique has been outlined previously and illustrated according to cleft type. For effective management of the unilateral cleft lip and palate and bilateral cleft lip and palate patients' maxilla, the standard Le Fort I osteotomy techniques had to be modified (Figs 1-2). The principle modification consisted of placement of soft-tissue incisions that allowed direct exposure for dissection, osteotomies, disimpaction, fistula closure, bone grafting, and application of plate-and-screw fixation that did not risk circulation injury to the dento-osseous-musculo-mucosal flaps. The routine surgical closure of residual cleft-dental gaps through differential maxillary segmental repositioning also was incorporated. For patients with unilateral cleft lip and palate or bilateral cleft lip and palate,
Figure 3. A 16-year-old girl with unilateral cleft lip and palate who underwent a modified Le Fort I osteotomy in two segments, bilateral sagittal split osteotomies of the mandible and an osteoplastic genioplasty is shown before and 2 years after surgery. (A) Preoperative frontal view in repose. (B) Frontal view in repose 2 years later. (C) Preoperative frontal view with smile. (D) Frontal view with smile 2 years later. (E) Preoperative oblique view. (F) Oblique view 2 years later. (G) Preoperative profile view. (H) Profile view 2 years later. (I) Preoperative occlusal view. (J) Occlusal view 2 years later. (K) Preoperative articulated dental casts. (L) Articulated dental casts after model surgery. (M) Preoperative cephalometric radiograph. (N) Cephalometric radiograph 1 year later. (Reprinted with permission from Posnick JC, Tompson B. Cleft-Orthognathic surgery: Complications and long-term results. Plast Reconstr Surg 1995;96:255.)

approximation of the maxillary segments for closure of the cleft-dental gaps also closed the dead space of the cleft alveolus and approximated the labial and palatal flaps to allow for straightforward closure of the recalcitrant oronasal fistula without tension, while providing keratinized mucosa to surround the cleft site(s) and adjacent teeth.
In anticipation of a degree of postoperative skeletal relapse, surgical overcorrection of several millimeters was planned in the horizontal and transverse dimensions. The exact amount varied with the interdigitation of the teeth.12-13

In our study, all but six patients (110 of 116 patients) underwent simultaneous autogenous cortico-cancellous iliac bone grafting. For patients with unilateral cleft lip and palate or bilateral cleft lip and palate, cancellous graft was used to fill all residual palatal, and floor-of-the-nose defects.14 After fixation of the maxilla with four miniplates, additional corticocancellous grafts were wedged between the zygomatic buttress and piriform aperture on each side and secured with microplates and screws.

Prefabricated interocclusal splints were used intraoperatively to facilitate correct placement of the jaws; the final splint was wired to the maxillary arch wire. Maxillo-mandibular fixation was generally applied for 2 to 4 weeks. The prefabricated splint remained wired to the maxillary arch wires for a total of 8 weeks to be certain that the relationship of the maxillary teeth to one

Figure 4. A 17-year-old patient with repaired bilateral cleft lip and palate. He initially presented in childhood with an elongated premaxilla, which eventually showed hypoplasia at skeletal maturity. His residual clefting problems were managed through a combined orthodontic and orthognathic approach using a modified Le Fort I osteotomy in two segments. (A) Preoperative frontal view. (B) Postoperative frontal view. (C) Preoperative lateral view. (D) Postoperative lateral view. (E) Preoperative occlusal view at 13 years of age. Note that the premaxilla appears to be long vertically. (F) After preoperative orthodontic treatment in preparation for jaw surgery at 17 years of age. (G) At 18 months after surgery and completion of orthodontics with resin build-ups of anterior teeth. (H) Occlusal view in mixed dentition phase. The cheek rotation flap used for fistula closure has decreased the vestibular depth and placed nonkeratinized mucosa over the tooth-bearing surface. A sliding mucogingival rotation flap would have been preferable. (I) Dental arch form after modified Le Fort I osteotomy with differential repositioning of three segments to close fistulas and cleft-dental gaps in the regions of the congenitally absent lateral incisors. (Reprinted with permission from Posnick JC, Witzel MA, Dagys AP. Management of jaw deformities in the cleft patient. In: Bardach J, Morris HL, editors. Multidisciplinary Management of Cleft Lip and Palate. Philadelphia, PA: Saunders, 1990:538.)
Figure 5. Twenty-three-year-old patient born with isolated cleft palate. She underwent a standard maxillary Le Fort I osteotomy with horizontal advancement and a vertical reduction and horizontal advancement genioplasty. (A) Preoperative frontal view in repose. (B) Postoperative frontal view in repose. (C) Preoperative frontal view with a smile. (D) Postoperative frontal view with a smile. (E) Preoperative profile view. (F) Postoperative profile view. (G) Preoperative occlusal view. (H) Postoperative occlusal view. (I) Preoperative oblique occlusal view. (J) Postoperative oblique occlusal view. (K) Articulated dental casts before surgery. (L) Articulated dental casts after model surgery. (M) Preoperative lateral cephalometric roentgenogram. (N) Postoperative lateral cephalometric roentgenogram. (Reprinted with permission from Posnick JC, Ewing MP. The role of plate and screw fixation in the treatment of cleft lip and palate jaw deformity. In: Gruss JS, Manson PM, Yaremchuk MJ, editors. Rigid Fixation of the Craniofacial Skeleton; Stoneham, MA, Butterworth, 1992;36:466-485.)
another and to the mandibular teeth remained unchanged. The segmental surgical arch wires were then replaced with a continuous arch wire and the orthodontic treatment was resumed.

**Orthodontic Technique**

The UCLP and BCLP patient who presented with maxillary hypoplasia and had not been grafted effectively in the mixed dentition would have two (UCLP) or three (BCLP) separate maxillary segments, each with a varied degree of dysplasia in all three planes. Each segment was evaluated and treated individually in anticipation of segmental surgical repositioning.

Radiographic assessment is essential before any orthodontic movement of teeth adjacent to the bone deficient cleft site(s). The panorex radiograph is primarily useful for assessing tooth angulation. Maxillary occlusal and periapical radiographs through the cleft site(s) can help assess the amount and height of the alveolar crestal bone of the adjacent teeth.

Both the number of permanent incisors and the amount of dentoalveolar bone in the anterior aspects of the maxilla will differ widely. Lateral incisor-like teeth frequently are found along the edges of the cleft site(s) in either the premaxilla (BCLP) or in the lateral segment(s). These generally are rudimentary with limited root support. When a poorly formed lateral incisor is present, it may be prudent to extract it in the interest of long-term function, aesthetics, and dental rehabilitation. Unerupted supernumerary teeth are also extracted either at the time of bone grafting in the mixed dentition or at the time of orthognathic surgery.

The decision to extract fully erupted normally formed teeth within the lateral segment(s) depends on the volume and height of the bone covering the dental roots adjacent to the cleft(s) and the degree of crowding within each segment. Bicuspid extraction(s) are often necessary to ensure that there is adequate bone for the levelling and aligning of all retained teeth without irreversibly weakening the periodontal support of the teeth adjacent to the cleft(s). The final occlusal result after orthodontic alignment and surgical repositioning of the lateral segment(s) will determine whether the maxillary third molars are required for opposing contact with the lower arch.

Planning for extractions in the mandibular arch depends on space requirements and on tooth movements needed to position the incisors ideally over basal bone. As may be used in the noncleft patient, an orthodontic trial set-up of the teeth is helpful in establishing the most appropriate extraction pattern. This is especially important when, after surgery, the mandibular arch will occlude with the maxillary arch where cuspsids and bicuspids are advanced to the lateral incisor and cuspid positions.

The orthodontist must be cognizant that placement of pre-angulated brackets, as is often used in a noncleft patient, or artistic positioning bends can displace the cleft adjacent root apices from their alveolar housing, with rapid loss of crestal bone height. Loss of vertical alveolar...
height along the cuspid tooth will occur with excessive mesial crown tipping.

Some patients lack sufficient bone in the premaxillary region to align the incisors preoperatively. For these patients, appliance placement is best delayed until after surgery. A passive sectional archwire is fabricated for the stabilization of surgical splints. Orthodontic movement is safe once the cleft defects are surgically closed and grafted.

Incorporation of all erupted long-term teeth in each maxillary segment within the orthodontic mechanics will facilitate arch leveling and development of the desired arch form. A lingual tube on the maxillary molar band allows the use of a trihelix expansion appliance to help correct extreme dentoalveolar collapse before surgery. The use of a lingual arch may stabilize the result.

The development of an ideal mandibular arch transversely is critical for effective repositioning of the upper maxillary segments in the most favorable position at the time of orthognathic surgery. The improved maxillary arch form may enhance stability and will improve speech articulation by providing adequate space for the tongue.

A prefabricated acrylic occlusal splint is wired to the maxillary orthodontic appliances in the operating room. Intermaxillary elastic fixation is generally applied for 2 to 4 weeks. With release of intermaxillary fixation, the diet is advanced to mechanical soft, but the acrylic splint remains wired to the maxillary brackets for a total of 8 weeks. Ideally, the orthodontist sees the patient on the day of splint removal and replaces the maxillary sectional archwires with a continuous archwire. The teeth are ligated together to maintain the surgical dental-gap closure. Active orthodontic treatment is reinitiated. Close monitoring for skeletal and dental relapse management is essential.

**Results**

Postoperative variables reviewed in our patients related to: (1) the condition of the clefted dento-alveolar region, including the presence of residual oronasal fistula, mobility of the premaxilla (in bilateral cleft lip and palate patients), adequacy of the bone bridge across the alveolus, any increase in gingival recession and root exposure of cleft adjacent teeth, success of closure of the cleft dental gap(s), presence of keratinized mucosa along the labial surface of cleft-adjacent teeth, and the need for a prosthetic appliance to complete dental rehabilitation; (2) perioperative complications; (3) the long-term maintenance of a positive overjet and overbite, as determined from the late postoperative cephalometric radiographs.Overall, 89% of residual fistulas underwent successful closures as part of the orthognathic surgical procedure. Surgical cleft-dental gap closure was achieved and maintained to the extent planned at 92% of the cleft sites. A fixed (prosthetic) bridge was used successfully for dental rehabilitation to close the gap(s) in all other patients in each cleft site (n = 9). All patients with alveolar clefts (n = 99) maintained keratinized mucosa along the labial surface of the cleft-adjacent teeth (n = 264 teeth).

Complications were few and generally not serious. There was no segmental bone loss or loss of teeth because of aseptic necrosis, infection or for other reasons. Only 5% of cleft adjacent teeth underwent a degree of gingival recession or root exposure as a result of the maxillary osteotomy procedures; all were retained long term. The long-term maintenance of overjet and overbite measured directly from the late (>1 year) postoperative lateral cephalometric radiographs indicated that 97% of patients maintained a positive overjet and that 89% maintained a positive overbite; 5% shifted to a neutral overbite.

**Discussion**

The described method for managing oronasal fistulas, alveolar defects, and cleft-dental gaps in patients with unilateral cleft lip and palate or bilateral cleft lip and palate is not intended to replace standard techniques and accepted sequencing of treatment. A two-stage approach for the adolescent born with a cleft and presenting with: maxillary hypoplasia; residual alveolar clefts; and fistulas is not cost-effective, and the potential overall morbidity is increased. It is in these patients with unilateral cleft lip and palate or bilateral cleft lip and palate that the modified Le Fort I osteotomy offers a
reasonable opportunity for the resolution of residual problems (ie, alveolar defects, residual fistulas, and cleft-dental gaps). There is a small subgroup of patients with bilateral cleft lip and palate who, in early childhood, have very large palatal fistulas combined with bilateral peri-alveolar ones. In general, there are only two options for fistula management in these patients. An anteriorly based dorsal tongue flap combined with an autogenous bone graft is a useful approach in the mixed dentition if the surgeon believes it will produce a successful closure with sufficient bone-graft take. If the size of the fistula, amount of dead space, and tissue deficit are very large, even a tongue flap may fail. The best option in these unique and difficult cases is to obturate the fistula with a temporary partial denture and maintain a cleft-dental gap(s) until early skeletal maturity, when a modified Le Fort I osteotomy is performed to finally resolve these problems. In a patient with UCLP or BCLP, prosthetic options for the management of the cleft-dental gap(s) in the region of the congenitally absent or inadequate lateral incisor(s) exist. From both facial aesthetic and dental health perspectives, the long-term use of a removable partial denture is always a second choice. Fixed bridgework is a reliable alternative but requires the partial destruction of adjacent normal teeth, frequently looks artificial, requires replacement at intervals throughout the patients life, and demands ongoing meticulous oral hygiene. Placement of a single-tooth osseous integrated implant is an attractive alternative, but the implant requires adequate bone height and volume that is not routinely present at the cleft site(s). These options are considered and compared with the method of simultaneous surgical cleft dental gap closure when maxillary hypoplasia also exists.

Other dental refinements for the cleft patient’s dysmorphic, often hypoplastic and decayed anterior maxillary teeth include porcelain-veneer build-ups, composite bonding, sculpting teeth, and bleaching techniques. Each of these refinements may improve the patient’s dental aesthetics, smile, and self-esteem and should be considered as part of an interdisciplinary team approach.

Uncertainties about velopharyngeal function and management of an in-placed pharyngeal flap should no longer be limiting factors when orthognathic surgery is necessary in a patient with a cleft. Awake nasoendoscopy performed in combination with clinical examination by a speech pathologist and surgeon familiar with cleft patients’ speech, can reliably predict current and expected velopharyngeal function in patients scheduled for a Le Fort I osteotomy. When significant postoperative velopharyngeal deterioration is anticipated, the patient and family should be educated about the sequencing of treatment, and alternatives should be discussed.

Conclusions
The methods described to manage jaw deformities, malocclusion, residual oronasal fistulas, and bony defects in adolescents born with a cleft are safe and reliable when these methods are performed by an experienced cleft surgeon and team. They enhance the patients quality of life and well-being. They also provide a stable foundation in which final soft-tissue lip and nose revisions may be carried out.

References
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