Pediatric Facial Plastic and Reconstructive Surgery

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Chapter 23: Pediatric Oral and Maxillofacial Surgery

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Surgical correction of bony deformities of the maxillofacial region is well established in the skeletally adult population. The timing and sequence of procedures in the growing child are more controversial, since it raises questions as to the effect of surgery on later growth of not only the specific bones that were osteotomized, but also of the maxillofacial complex as a whole. Data is often limited, particularly in terms of long-term follow-up of significant numbers of patients.

Mandibular advancement for example, may be successfully carried out in growing children with true mandibular retrognathia. There seems to be reasonable stability of the maxillomandibular relationship, with both the maxilla and mandible exhibiting harmonious growth. However, treatment of mandibular prognathism during growth has a high rate of relapse and is thus usually done after cessation of growth. In contrast, Le Fort III osteotomy in the growing child does not seem to affect subsequent facial growth, either adversely or favorably.

Of considerable concern is the effect of Le Fort I osteotomies on midfacial or nasal growth. Even groups that have performed "early" (ages 10 to 14) Le Fort osteotomies for vertical maxillary excess advocate consideration of procedures that avoid significant septal resection. The position of unerupted teeth may force alteration of the osteotomy lines. Most surgeons currently advocate waiting until mid- to late adolescence before performing a Le Fort I osteotomy.

Midface osteotomies most likely "do not enhance growth of the underdeveloped midface". If they are done, some overcorrection is thought to be necessary. In general, most orthognathic surgery is still done after cessation of growth. However, the evaluation of and preoperative management with orthodontics is begun earlier.

This chapter presents an outline of common maxillofacial deformities, stressing evaluation, timing considerations, and treatment modalities, with particular attention to how these modalities must be modified for the growing child.

Common Maxillofacial Deformities

The most common maxillofacial deformities in children are mandibular hypoplasia and mandibular hyperplasia. Maxillary size discrepancies are also quite common. These may result in maxillary hypoplasia, hyperplasia, or width discrepancies. Excessive vertical growth of the maxilla also occurs commonly, giving the patient a "gummy" smile. Associated open bite deformities may be quite dramatic and can result in significant speech-related difficulties. These discrepancies may be present in early childhood, but usually become more of a concern after puberty and its associated rapid growth.

Asymmetric facial growth in the nonsyndrome patient most commonly occurs secondary to asymmetric mandibular development. This is generally due to unilateral hyperplasia or hypoplasia of the condyle or ramus. If these occur during somatic growth, there is usually concomitant maxillary compensation, resulting in a broader maxillofacial asymmetry. As in all cases of maxillofacial discrepancies, a thorough evaluation must be made to determine if the deformity is part of a syndrome such as hemifacial microsomia. Sequential studies are usually needed to determine that the asymmetric growth has ceased. These may include asymmetry analysis of a posteroanterior (PA) cephalometric radiograph, lateral cephalometric study, models of dentition, and bone scans to assess differential activity.

Soft tissue changes following orthognathic surgery tend to be only broadly predictable. Most studies show significant individual variation from the mean. This will be elaborated upon in the section on treatment planning and predictions. Variation is compounded when dealing with the growing child who will have not only more bony growth, but also soft tissue modifications associated with secondary sexual changes. In general, secondary soft tissue alterations following osteotomies should be delayed for at least 9 to 12 months.

Special Considerations

Congenital cleft lip and palate deformities represent a significant number of patients requiring secondary maxillofacial surgery. Because of the complexity of this subject as it relates to oral and maxillofacial procedures, this is covered in Chapter 16 by Kuo, Will, and Albert.

Evaluation and Treatment Planning

General Considerations

Volumes have been written in the surgical and orthodontic literature concerning hard and soft tissue evaluation of the maxillofacial region. We will concentrate on the relatively common and simple evaluation methods that usually define most of the problem. Of course, no technical evaluation can replace a careful history, listening to the patient's perception of the problem, and clinical experience. The technical data helps to define the details. Ideally the problem must be evaluated in lateral, anteroposterior (AP), and transverse dimensions.

The most common diagnostic workups for dentofacial deformities include lateral cephalometric radiographs and analysis for both hard and soft tissue, dental radiographs and analysis for both hard and soft tissue, dental radiographs, occlusal evaluation with dental models, and aesthetic facial analysis. These are usually subdivided further to look specifically at the upper, middle, and lower thirds of the face.

Cephalometric Analysis

Cephalometry, particularly the lateral view, is one of the most commonly used diagnostic tools. It allows for reasonable, objective, and reproducible analysis pre- and postoperatively and lends itself to prediction tracing. Most studies of orthognathic surgery have relied heavily on this analysis. A large number of different systems for cephalometric analysis have been devised, the details of which are well beyond the scope of this chapter.

The common features are the bony landmarks of the nose, midface, mandible, and dentition, and their relationships to consistent bony landmarks of the normal skull and to each other. Normative data have been generated. It is important to note that most norms have come from Caucasian or European groups. Anteroposterior, transverse, as well as vertical dimension, can be measured.

A properly exposed cephalometric radiograph will also include the outline of the soft tissues. These can also be analyzed by tracing out the soft tissue contours. Prediction tracings can be generated for any particular procedure. Hard tissue changes are much more predictable than soft tissue, particularly in the adult or nongrowing patient. As discussed previously, relative relationships of bony landmarks in procedures such as mandibular advancement may remain stable; however, absolute positions will change with growth.

Computerized imaging has expanded greatly in the last several years and includes both hard and soft tissue analysis. Video imaging allows for creation of possible soft tissue changes that can be readily visualized by the patient. However, it is important to emphasize again that actual soft tissue changes show a wide individual variation for most parameters. Caution must be used in implying that the actual end result will match the video image.

Orthodontic/Dental Evaluation

Examination of the individual teeth as well as their relationship to one another is critical. Today well over 95% of orthognathic surgery cases are done in combination with orthodontics. Some significant soft tissue changes can be achieved by orthodontic manipulation only. However, changes in tooth position are limited by bony position, ie, the teeth must be moved within the bone itself. Trying to compensate for a true bony disharmony with orthodontics alone gives a less than satisfactory result.

Transverse discrepancies manifested as maxillary constriction are most readily analyzed by examining the dental casts and a PA cephalometric radiograph. In the growing child, rapid palatal expansion reliably produces widening by taking advantage of the nonfused, midpalatal suture. This can usually be achieved with an orthodontic appliance over a period of 2 to 8 weeks. The device can be activated by as much as 0.5 mm per day. Care must be taken to make sure the maxilla itself is expanding at the palatal suture, rather than the teeth being tipped and/or extruded. In rare circumstances, surgically assisted rapid palatal expansion is needed in the older child. This involves performing lateral maxillary corticotomies, usually on an outpatient basis, before activating the expansion device.

The goal of orthodontic evaluation is to determine what is necessary orthodontically to align the arches and allow the teeth to interdigitate after osteotomies are performed. Close consultation between the orthodontist and the surgeon is required.

Timing Considerations

Timing and sequencing of maxillofacial orthognathic surgery is still one of the most controversial questions. As discussed earlier, in the adult population where most of the data exist, there is wide individual variation in the correlation of hard tissue and soft tissue changes. In the growing child there is the additional concern that osteotomies may affect the growth potential of the particular bone itself or the contiguous bones. Excluding patients with craniofacial syndromes, most patients come to the maxillofacial surgeon's attention in early adolescence. This is probably due to a combination of factors. Most orthodontic evaluation and treatment begins about this time. Major discrepancies elicit more peer pressure for possible change. More permanent teeth are erupted, which allows for better orthodontic evaluation and treatment. The majority of maxillary growth is achieved during this period. Patient cooperation tends to improve as the child becomes older. Technical concerns such as tooth bud position and bony anatomy that may limit the osteotomy tend to diminish toward the end of growth.

Mandibular Deformities

Mandibular hypoplasia is usually defined both cephalometrically and dentally. Cephalometric analysis will show the mandible to have below normal AP length in relationship to the cranial base with a normal maxillary AP dimension. Dentally a class II molar relationship exists with the mesiobuccal cusp of the maxillary first molar anterior to the buccal groove of the mandibular first molar.

Vertical height of the mandible, as well as the prominence of the chin button or menton, must be assessed. A retrusive menton will accentuate the aesthetic aspects of the retrusive mandible. As discussed earlier in this chapter, the limited data available concerning mandibular lengthening in the normal, growing child (ages 8 to 12) seem to indicate no adverse effect upon later mandibular growth or upon the maxillofacial complex.

The sagittal split osteotomy is the most common technique utilized for mandibular advancement. This may be used in combination with chin advancement.

Special considerations in the growing chil include position of the developing tooth buds of the second and third molars and location of the lingula of the mandibular foramen. The second and third molar tooth buds are often high and lateral, near the buccal cortex, where the vertical cut is usually made. A more posterior buccal cut may significantly reduce the amount of overlapping bone. The tooth bud position is also a consideration in interosseous wire placement or in the use of rigid fixation with plates and screws.

The lingula of the mandibular foramen is located more posteriorly and sometimes more superiorly on the ramus of the growing child. This usually necessitates the medial horizontal cut being made to the posterior border. In addition, there must be adequate bone superior to the cut to allow for coronoid continuity in the proximal segment. Getting the mandibular nerve to stay in the distal segment can be more difficult in the younger patient as the nerve is more central in the mandible.

One of the major potential complications of the sagittal split osteotomy is paresthesia or anesthesia of the mandibular nerve. No studies have been done to show the effect of partial loss of function of the third division on muscle and bone growth. Observations of congenital nerve loss indicate the potential for underdevelopment. A minor complication is that most osteotomies require some period of maxillomandibular fixation. Facial contour changes following mandibular advancement can be dramatic. Much of this is secondary to chin position changes. In patients with retrusive chins, simultaneous chin advancements can be considered. Stability of sagittal split advacements is correlated with magnitude of advancement. The greater the advancement the greater the likelihood of partial relapse.

Fixation for mandibular osteotomies is usually twofold. The osteotomy site itself may be fixed with wire osteosynthesis, lag screws, or miniplates. Some controversy exists as to the best method. Wire osteosynthesis either at the superior or inferior border requires the use of maxillomandibular fixation for 4 to 6 weeks. Rigid fixation may eliminate or reduce the need for maxillomandibular fixation; however, it may increase the risk of secondary temporomandibular joint changes and nerve injury. An extraoral approach with a trocar is sometimes necessary when applying plates and screws, and carries a small risk of facial nerve injury.

Mandibular Retrognathia and Vertical Ramus Deficiency

A less common finding is that of mandibular retrognathia and vertical ramus deficiency. This is most commonly found in cases of hemifacial microsomia and Goldenhar's syndrome. Vertical osteotomies can be used to lengthen the ramus without advancing the mandible. Inverted L osteotomies with an interpositional bone graft are used to both lengthen the ramus and advance the mandible.

Mandibular Prognathism

True mandibular prognathism is present when the mandible is longer than a normal-sized maxilla. Relative mandibular prognathism exists when the mandible is normal length and the maxilla is found to have a diminished anteroposterior dimension as measured cephalometrically.

For true mandibular prognathism the mandible is set back either with a sagittal split osteotomy (with ostectomies) or with a vertical oblique ramus osteotomy. The vertical oblique osteotomy may be modified to preserve coronoid position, or a coronoidectomy may be performed.

Timing considerations are important because the mandible usually continues to grow until the cessation of somatic growth. Treatment before the end of growth usually results in partial relapse requiring a second surgery, and is considered only for extreme cases of mandibular prognathism.

Mandibular growth after the cessation of somatic growth is often associated with a growth hormone secreting pituitary adenoma or with condylar hyperplasia, which may be unilateral or bilateral. Once the etiology has been determined and treated, mandibular osteotomies may be employed.

Genioplasty

Alteration of the chin position via a horizontal osteotomy may be accomplished as a separate procedure or at the same time as a mandibular ramus osteotomy. The bony position is evaluated with a lateral cephalometric radiograph. Chin implants may also be considered. No studies have been done as to the effect of a genioplasty alone on mandibular growth in a growing child.

In cases of mandibular asymmetry, the chin position itself is often not in line with the dental midline. A lateral shift should be considered in these cases.

Maxillary Deformities

In the nonsyndrome child, maxillary size and position show wide variation in the most commonly used measurements of vertical height, horizontal position, and width. Washburn et al in their extrapolation of data from multiple studies in facial growth, showed that, *on average*, most maxillary growth is completed by the time of canine eruption or between the ages of 10 and 13. The different studies, however, showed wide variations among individuals, as well as between the sexes, with boys generally reaching the 95th percentile several years later than girls. Although Washburn et al reported no particular adverse effects of Le Fort I osteotomy for correction of vertical maxillary excess, most of the patients were operated on after the majority of maxillary growth was complete. In addition they recommended using a complete alveolar osteotomy in order to avoid potential facial growth disturbances secondary to resecting the nasal septum. This particular area of concern (effect of resection of nasal cartilage on subsequent facial growth) is not well defined in research or clinical studies.

Timing is also affected by technical considerations such as tooth bud position. Sailer has shown that the buds of developing teeth in young children are positioned nearly at the infraorbital rim. Developing molars are high in the posterior wall of the developing sinus. Kaban, in taking all of these factors into consideration, states, "Le Fort I osteotomy should only be performed after the permanent teeth are fully erupted." The exception to this would be in regard to third molar (wisdom tooth) eruption.

Signifant controversy still exists as to whether nasal airway obstruction leads to vertical maxillary excess (VME). There have been no definitive studies to show any indication that early correction of nasal airway obstruction in patients with VME would lead to a diminution of their VME.

The relationship of VME (or maxillary deformities in general) to mandibular growth and position and open bite deformities is also inconclusive. West, in his review of the pertinent literature, found a multiplicity of factors and findings in this regard. Most vertical maxillary dysplasias are dentoalveolar in origin, with the palate varying little in its vertical position. Thus, much of the surgical approach must focus on changes in dentoalveolar position. Depending upon mandibular position, correction of maxillary deformities often requires mandibular osteotomies as well.

Maxillary Evaluation

Lateral skeletal cephalometric analysis is the mainstay in determining horizontal and vertical maxillary position. Normative data must always be reviewed in light of the individual. Width analysis is mainly on the basis of dental casts and occlusal analysis, although this can be misleading if there is a great deal of tipping of teeth. A posteroanterior cephalometric radiograph allows for more reliable bony measurements of width.

Soft tissue evaluation is currently done mainly from lateral soft tissue outlines. Computerized analysis may provide for better three-dimensional evaluation in the future. The real challenge is in the predictability of soft tissue changes secondary to hard tissue movements. So many factors seem to be involved, with so much individual variation, that the conclusion one draws is that there is more art than science in soft tissue predictability. What is known is that changes will occur in absolute and relative lip length, nasal tip, and alar base morphology, and in the commissure of the mouth. Significant patient dissatisfaction can arise if absolute predictions are made. Secondary revisions often need to be considered.

Maxillary Procedures

The Le Fort I osteotomy is the most common technique for changing maxillary position. The basic technique may be modified for individual reasons. The maxilla may be divided into multiple pieces to compensate for width or vertical discrepancies. In most cases it is preferable to deal with these orthodontically preoperatively, as division into multiple pieces increases the risk of avascular necrosis and nonunion or periodontal problems.

In patients with infraorbital hypoplasia, a "high" Le Fort I osteotomy may serve to fill out this area. Here the anterior level of the cut is raised. The infraorbital nerve may have to be dissected out and repositioned.

Cases of severe VME may cause significant impingement on the nasal septum and turbinates as the maxilla is shortened in its vertical dimension. A separation of the alveolus from the palate may be a necessary modification along with turbinectomy or turbinotomy.

The alar base is usually widened in vertical shortening of the maxilla. Bone grafting may be necessary in cases where gaps greater than 5 mm occur either vertically, as in vertical elongation, or horizontally, as in an impaction and/or advancement. Rigid fixation is preferred for virtually all Le Fort procedures. It is particularly helpful in vertical elongation. Bone grafts are often fixed to the plates as well. With use of rigid fixation, maxillary advancements rarely require posterior bone grafts. Le Fort osteotomies in patients with cleft deformities require special considerations and is covered in Chapter 16 by Kuo, Will, and Albert.

Asymmetry

Asymmetric facial growth may occur for a variety of reasons, either congenital or acquired. The most common congenital etiology is hemifacial microsomia, which has a variable, progressive presentation. It involves soft tissue, skeletal, and neuromuscular aspects of the face. Secondary mandibular and midfacial deformities develop routinely. Reports have shown that intervention during growth can enhance potential growth of the mandible and decrease or prevent secondarty deformities.

Acquired abnormalities that can produce asymmetric growth include condylar hyperplasia, trauma, radiation therapy, tumors, juvenile rheumatoid arthritis, and infections. Developing a rational treatment plan is dependent upon determining the etiology. Appropriate studies such as radiographs, bone scans, and orthodontics evaluation are therefore necessary. Symmetry analysis is usually done in the AP mode.

In most cases of asymmetric growth occurring during childhood or before the end of somatic growth, there are compensatory changes in surrounding structures. For example, in cases of condylar hyperplasia, the maxilla will also grow asymmetrically. Treatment must take this into account. It is therefore common to perform corrective orthognathic surgery in both jaws.

In the noncongenital or acquired asymmetries, it is important, after determining the etiology, to also determine that the process has stopped or been corrected without recurrence before proceeding with corrective orthognathic surgery. This usually requires serial bone scans, symmetry analysis, orthodontic models, and cephalometric radiographs.

In general, the key to a satisfactory aesthetic result is to establish the correct maxillary position and then set the mandible to it. Often, the maxilla must be leveled to obtain a normal horizontal occlusal plane. This is facilitated by the use of rigid fixation with miniplates. Large gaps may have to be bone grafted. Preoperative orthodontics is usually required.

Mandibular alignment usually requires asymmetric movement. If the mandible is deviated to the right for example, it may have to be lengthened on the right and retruded or shortened on the left. Even if one side does not require significant lengthening or shortening it is usually advisable to perform an osteotomy to allow for rotation around a vertical axis in the ramus. Attention must also be paid to the width of the mandible, particularly in the posterior. Onlay grafts may be used, often as a secondary procedure.