Orthodontic Considerations for Maxillary Distraction Osteogenesis in Growing Patients with Cleft Lip and Palate Using Internal Distractors

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Abstract

Keywords

- internal Le Fort I distractor
- maxillary distraction
- distraction osteogenesis
- maxillary hypoplasia
- cleft lip and palate

The orthodontist plays a key role in the selection of the optimal treatment for patients followed by a craniofacial team. For patients with cleft lip and palate, the need for multidisciplinary treatment planning and sequentially staged treatment is essential for successful patient outcomes. The technique of Le Fort I distraction osteogenesis of the maxilla using an internal device is potentially a predictable, stable, and convenient option for the correction of severe maxillary hypoplasia. It is an alternative option for treatment of maxillary hypoplasia in growing patients. In this article, the authors describe the orthodontist's approach to the management of cleft patients with severe maxillary deficiency with the use of an internal distraction device. The information is presented with a focus on the clinical aspects of treatment, using case illustrations and appropriate literature.

Maxillary hypoplasia is a common developmental problem in patients with cleft lip and palate (CLP), and normally results from a combination of a congenital reduction in midfacial growth and the effects of the surgical scar from cleft palate repair.^{1,2} As a result, CLP patients usually present with class III malocclusion, a retruded midface, and a narrow hard palate. In most situations, surgical correction following cessation of growth is required to treat severe skeletal disharmony. However, individualized evaluation and treatment planning is recommended.^{3–5}

The technique of DO has provided new ideas and methods for the correction of sagittal, vertical, and transversal maxillary discrepancies.^{6–9} Distraction osteogenesis gradually lengthens both the bones and the soft tissues, then greatly

lowers the soft tissue restriction around the distracted segment and lowers the relapse rate. The technique of Le Fort I DO using an internal device is potentially a predictable, stable, and convenient option for the correction of a severe unfavorable intermaxillary relationship. It is an alternative option for treatment of maxillary hypoplasia in growing CLP patients where continued growth of the mandible is expected.^{10,11}

In the craniofacial team setting, the orthodontist assists in planning distraction surgery, developing or adapting distraction devices, and managing postsurgical results. Our purpose here is to describe the orthodontic approach to the management of cleft patients with severe maxillary deficiency with the use of an internal distraction device. The information is

Fig. 1 Cephalometric tracing from a patient with cleft lip and palate followed by a craniofacial team showing the sagittal growth during the late mixed dentition (2009) to early permanent dentition (2011) with increased mandibular growth with arrested maxillary growth.

presented with a focus on the clinical aspects of treatment, using case illustrations and appropriate literature.

Potential Clinical Indications

For many maxillofacial surgeons, 10 mm is a relative limit for a one-step Le Fort I advancement. Exceeding this limit will bring risks of postoperative instability and potential for relapse. For patients with maxillary hypoplasia secondary to cleft lip and palate repair, this limit may be reduced to 6 mm or less because of the local soft tissue scar restriction and the preoperative velopharyngeal incompetence.¹⁰ Moreover, for some patients with cleft lip and palate, a severe maxillary hypoplasia and class III malocclusion will appear early in life and conventional orthognathic operation cannot be performed until adolescence, when growth of the jaw is nearly complete. This can have a great deleterious effect on the patient's negative overjet at skeletal maturity and psychic development.^{12,13} For those CLP patients requiring greater than 5 to 6 mm of maxillary advancement, or presenting functional deficits due to retrognathic maxilla involving

speech, sleep apnea, nutrition, or self-esteem, distraction osteogenesis (DO) of the maxilla with internal devices is a promising treatment alternative (**→Fig. 1**).³

Treatment Planning and Patient Preparation

A typical profile of a patient with cleft lip and palate tends to show overclosure of the mandible, poor maxillary incisor display, nasal deformity, a thin upper lip, a full lower lip, and upright maxillary incisors caused by lip tension from previous lip surgeries. Intraorally, a significant finding in cleft patients is a collapsed malaligned arch. The orthodontic preparation for maxillary distraction is similar to the conventional orthognathic preparation for class III malocclusion. Both treatments decompensate the anterior teeth to maximize skeletal correction during treatment and coordinate arches. The presurgical requisite is the widening of the arch and aligning the teeth for correction of occlusal interference. The occlusal instability after maxillary distraction might lead to potential skeletal instability. To promote the separation of the occlusion/bite, an alteration in the direction of the bite

Fig. 2 Predistraction facial and intraoral photographs. Note the anterior crossbite, uprighting of upper incisors in both cases. (Case A) Note the occlusal pads to allow initial leveling; more favorable horizontal growth pattern, balanced facial profile. (Case B) Note a modified transpalatal arch to improve arch coordination in preparation for distraction.

force assists the maxilla and mandible to adopt the new position. The upper and lower dental arches are separated by the occlusal pads or a removable bite block, which effectively alter the relationship of the molars by encouraging clockwise rotation of the mandible (►Fig. 2).

In three-dimensional (3D) virtual surgical planning (VSP) generated from computed tomography (CT) images the distraction is simulated with respect to the sagittal, transverse, and horizontal planes. The necessary dental movements are anticipated by performing a 3D virtual orthodontic set-up on the skull model. The desired vector of distraction and the osteotomy line are defined by the surgeon and orthodontist in planning. These data will be used to transfer the distraction vector into a stereolithitic model of the midface, utilizing a prefabricated zygomatic footplate positioning guide. The predetermined distraction vector is implemented with a distractor angle guide. The guides assure fidelity of the VSP plan to the live patient intraoperatively. Changes in the design

of distractors may be necessary to minimize patient discomfort (►Fig. 3).

Orthodontic Management during Distraction and Consolidation

After a latency period of 5 to 7 days, distraction starts at the rate of 0.5 mm twice a day achieving a distraction of 1 mm/d. The orthodontist must be ready to follow the patient closely to ensure patient compliance. During the distraction phase, there is a tendency to a counterclockwise rotation of the maxilla, and an open bite that is corrected by elastics during the consolidation period. The newly generated bone is still soft and allows molding. After the amount of distraction is achieved, an 8-week consolidation period is completed before the devices are removed. If needed, the internal devices can be removed earlier, allowing better molding and position of the maxilla with rubber

Fig. 3 The virtual planning for the patient presented as Case B in ►Fig. 2. Note the planned vector of distraction, the placement of the internal distractors, and final occlusion. The final occlusion can be assessed and any interference along the distraction process can be anticipated.

Fig. 4 Patients during consolidation phase with internal distractors still in place. (Case A) Note patient undergoing class III and vertical elastics therapy to achieve dental intercuspation. Note the good control of oral health in both cases. (Case B) Note the improvement in the facial appearance especially for a teenage boy despite the unfavorable growth pattern.

bands. The orthodontic appointments must be scheduled more often than in a conventional treatment approach. There is improved efficiency of orthodontic forces related to the process of demineralization and remineralization consistent with the wound-healing pattern of the regional acceleratory phenomenon (RAP) (►Fig. 4).

Discussion

The prognosis of the early treatment of class III malocclusion is controversial within the orthodontic community. Several orthopedic treatments for growing patients such as a chin cap, face-mask, and functional appliances have been attempted with successful results, although there have been many long-term failures because of a discrepancy between maxillary and mandibular growth. In general, if adverse growth is expected, orthodontic treatment should be delayed until the growth is complete.^{14–18} On the other hand, when the maxilla is distracted to allow catch up to the mandibular growth at the treatment point during childhood, masticatory function is improved and acquired during growth stages. In addition, the correction of class III dentoskeletal deformities during these growth stages might have a control effect on the subsequent mandibular growth and has a strong impact on the patient aesthetically and socially.^{19,20} Finally, early Le Fort I DO will prevent the need for large jaw movements upon cessation of growth, increasing the chances of long-term skeletal stability.

When cephalometric predictors of long-term stability in the early treatment of class III malocclusion are considered, it seems that for the final prognosis, the individual characteristics of the mandibular growth and shape are more important than the maxillomandibular sagittal relationships.^{17,21} Generally, the patients with a smaller gonial angle and a more hypodivergent skeletal pattern had good prognosis after the early treatment of class III malocclusion.^{17,18,21,22}

Although rigid internal fixation and bone grafting have greatly improved the postoperative stability of orthognathic surgery, the soft tissue scar restriction and the poor quality of skeletal bone available for rigid internal fixation still make the

relapse rate higher for CLP patients. Nevertheless, maxillary advancement with DO has become a viable option in CLP patients with medium or severe midfacial/maxillary deficiency. Distraction breaks the resistance created by the scar tissue and allows distraction of the soft tissue at the desired level through proliferation (histogenetic effect) along with bone distraction. With DO, the maxillary advancement can exceed the 10-mm limitation compared with traditional orthognathic procedures. This is very significant for patients with cleft lip and/or palate, for they often need maxillary advancement of more than 10 mm to achieve a normal facial appearance and occlusal relationship.^{23–25}

At this point, even though the postdistraction growth cannot be accurately predicted, the procedure allows better growth and psychosocial development and minimizes the amount of sagittal discrepancy if a second surgery is needed. Maintaining teeth in their corrected position after orthodontic treatment is challenging, and practitioners commonly recommend long-term or permanent retention. The effects of growth are not easily described, and their effects on the occlusion could be positive, negative, or neutral. Whether growth will help or hinder a patient depends primarily on the initial malocclusion, the posttreatment occlusion, and the amount and direction of subsequent growth.^{17,21} These possible effects should be discussed before maxillary distraction is attempted in growing patients. However, the patient's chief complaint, dental function, and facial aesthetics that can be achieved and improved early in life should be addressed as well. The skeletal treatment of the maxilla utilizing DO in growing CLP patients should be discussed among the patient, family, and craniofacial team to ensure all risks and side effects are discussed for a complete informed consent. It is possible that the patient will require an additional orthognathic surgery at the end of the growth period or additional orthodontic treatment may be needed to accomplish a final functional occlusion.

To take advantage of RAP phenomenon, it is mandatory that orthodontic techniques assist the maxillary distraction procedure. The phenomenon of postoperative accelerated

orthodontic tooth movement could be caused by the improvement in dental and muscular function postoperatively or the changes in bone physiology and metabolism induced by orthognathic surgery as proposed by Liou et al.²⁶ The orthognathic surgery triggers 3 to 4 months of higher osteoclastic activity and metabolic changes in the dentoalveolar complex postoperatively, which may accelerate postoperative orthodontic tooth movement.^{26,27} The newly formed soft bone after distraction could be molded by using inter arch elastics to achieve better interdigitation of teeth. This settling of the occluding teeth might contribute to maintain the sagittal advancement. The use of class III elastics is indicated as an active retention after maxillary distraction.

Summary

In the context of careful patient selection and team-based treatment planning, the use of an internal distractor to approach maxillary hypoplasia in growing CLP patients offers a predictable treatment option to restore facial convexity and functional occlusion. In the authors' experience, this procedure can achieve high levels of patient and orthodontist satisfaction. However, the orthodontist should be prepared to manage surgical cases. Special attention should be given to achieve dental intercuspation during the consolidation phase. Therefore, the presurgical orthodontic treatment phase may be extensive to achieve arches coordination and the use of interarch elastics postoperatively is helpful to finalize the occlusion even at the consolidation phase.

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