Maxillary Distraction Osteogenesis for Advancement in Cleft Patients, Internal Devices

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Choosing a maxillary distraction device or any distraction device is based upon the surgical goals intended for the individual patient. Choosing a device for the cleft lip and palate patient with skeletal maxillary deficiency is no exception. The basic goals of any maxillary advancement surgery are to create a stable functional occlusion and good facial esthetic form.

External distractors were originally used to advance the severe skeletal deformities of patients with not only cleft lip and palate, but other more severe craniofacial anomalies. These devices have the benefit of being able to be adjusted in 3 dimensions as the maxilla, midface, and orbits are moving forward. They have been used in children as well as adults. They can be attached to the bone or to the dentition. Disadvantages of these external devices are that they are worn as an external “halo” during the distraction and consolidation period, creating a difficult psychosocial setting (Fig 1) for children and adults already dealing with the stigma of a facial deformity.1-3 The pins that secure the device to the skull can loosen and need to be tightened over the period of fixation. These constant tightening adjustments may lead to perforation of the inner table of the skull.1,4 Our indication for use of distraction of the maxilla in cleft and patients with severe maxillary skeletal anterior-posterior deficiency is as a staging surgery. Our group uses distraction just like the SARPE procedure, where transverse skeletal problems are addressed to increase long-term stability of large skeletal movements.5 Because the movement of maxillary distraction is to gain horizontal advancement initially, we have found the use of external distraction devices is unnecessary in our hands. This saves the patient from the psychosocial stigmata that come from the use of any extra skeletal fixation devices. We have also found that these internal devices are more stable compared with the wires that stretch off the maxilla attached to the external devices. Thus, during the period of consolidation the maxilla maintains stability better because the internal devices act more like rigid fixation.

The evolution of submerged submucosal devices has allowed the patient to have advancement of the maxilla with the devices buried under the mucosa intraorally.6-9 The access to the distraction activation rod is next to the molar and bicuspid teeth (Figs 2A,B).

The concept, once again, is similar to the palatal expansion devices we use to surgically widen the maxilla with their screw on the hard palate. Just like the external devices, maxillary distraction devices then can be either anchored to the bone or to the teeth.

The greatest disadvantage of these internal devices is that most of these internal distraction devices are unidirectional and cannot be manipulated to move the maxilla in 3 dimensions. Thus, if the treatment goal is to establish a final occlusion with 1 surgery, then these devices are not the answer; that is, unless a straightforward movement is all that is needed. However, because we are using these distractors for a staging surgery, the final outcome will be the same: a functional and esthetic and stable result. Remember, with careful planning of the vector of movement, prebending the distractors on 3 dimensional models (Figs 3A,B), and orthodontic presurgical set up, a very predictable movement can be achieved, even a final occlusion in the adult patient.

The patient born with cleft lip and palate is faced with a lifetime of surgical interventions to correct this skeletal facial deformity. Often we pay the price of deficient maxillary skeletal growth in lieu of having a closed lip, hard palate, and functioning soft palate as an infant. Previously, we have presented our long-term follow up results on 31 patients with cleft lip and palate after alveolar bone grafting. These patients
were all followed to skeletal maturity. The patients were found to have a 75% chance to develop maxillary anterior-posterior as well as vertical deficiency. These results were based upon strict analysis of standard cephalometric values. Of those patients, only 50% needed to have orthognathic correction of the skeletal deficiency. The remainder had been masked with compensated orthodontic manipulation or prosthetic rehabilitation (Abstract ACOMS 2004).

Distraction osteogenesis should be considered in cleft patients when these maxillary deficiencies are so severe (Figs 4A, B) that standard corrective jaw surgery will only be fraught with higher risk of instability and relapse.\textsuperscript{4,5,9-12} Standard jaw surgery may commit the patient to possible further unpredictable surgical interventions. Deciding which cleft patients should be candidates for distraction then should be done on an individual basis. How far the maxilla needs to be advanced, the age of the patient, and the amount of scar tissue present, including the presence of a velopharyngeal flap, are all factors to consider when deciding upon using a distraction device.

Our protocol for using distraction has evolved over the past 15 years. At this time, it is our opinion that by the time the child is 12 to 13 years old with a significant cleft-related maxillary deficiency of greater than 10 mm regardless of mandibular position at that time, distraction should be considered to advance the maxilla. This advancement will provide a base for the soft tissues of the nose and midface and balance the skeleton, provide a more functional occlusion, improve speech (notwithstanding velopharyngeal incompetence and potential need for pharyngeal flap surgery) and most importantly, help these children into a better psychosocial atmosphere. As stated previously, in the growing cleft patient, we are using distraction as a staging surgery. One could compare this concept to the use of surgically assisted palatal expansion, where transverse skeletal width is achieved before advancement to increase stability of the surgical result of standard corrective jaw surgery. Therefore, at the end of the distraction advancement any skeletal width deficiency issues are addressed with expansion.

In the adult cleft patient population we have been using distraction as well to advance the maxilla in a...
staged fashion when the deficiency is greater than 12 mm. Otherwise, standard orthognathic surgical protocols have been followed. We are using this device to not only grow the maxillary bone, but also to tissue expand as well for the maxilla to maintain stability. A final occlusion may need to be established via Le Fort I at the time of distractor removal. Once again, if there are width deficiency issues, they are also addressed once we have achieved skeletal stability at the time of distractor removal.

Our distraction technique is as follows:

In the adult and/or child with adult dentition, all dental compensations are removed prior to distraction and a surgical wire is placed. If there is to be widening after distraction is consolidated then a palatal expander is to be placed before distraction. This is especially helpful in the cleft patient to maintain transpalatal stability. Oftentimes the areas of grafted bone are thin in the adult population and may not offer good transpalatal stability.
Prebend the distractors using 3-dimensional models. Establish the vector with paper surgery or computer-guided model surgery, or standard model surgery may be used off of the plastic skulls or regular models (Fig 3B).

Complete the Le Fort I and placement of distractors (Fig 5).

Start distraction at 7 days: latency period. Rate and rhythm is 1 mm/day broken up into 2 0.5-mm turns.

Consolidation 16 weeks. Establish bone formation with computerized tomography (CT) evidence at the pterygoid plates (Fig 6).

Our protocol is in contrast to the many teams that elect to remove the distractors after 8 weeks or earlier to “manipulate” the regenerate. In advancements that are greater than 12 mm it is necessary to wait longer to get good solid bone. The distractors function as bone plates during this time (rigid fixation). We have found that when we have removed the fixation early, there has been an increased tendency to lose the advancement due to scaring and retraction of the soft tissues. Thus, we wait for bone consolidation.

Decisions to make at the time of distractor removal:

ADULT PATIENT

We have 3 possibilities: 1) good occlusion back to the orthodontist to finish. The patient should have had the occlusion level and aligned prior to distraction surgery. A surgical archwire and possibly a SARPE device should be cemented into position. 2) Width discrepancy remains: SARPE at time of removal. 3) Occlusion to be established with corrective jaw surgery: that is, Le Fort I and bone plates at the time of distractor removal to correct any vertical or asymmetric skeletal malocclusion at the end of distraction. Occlusion should be established with model surgery and splint fabrication to settle the maxilla into appropriate occlusion.

GROWING PATIENT

1) SARPE if width is deficient. 2) Orthodontic alignment and allow growth to complete. 3) Follow facial growth with serial cephalometric studies.

We have advanced a total of 16 patients via some form of maxillary distraction over the past 15 years. Our first case was an 11-year-old male with cleft-related maxillary deficiency. He had a “modified” Le Fort I and a Delaire face mask with 16 oz elastics. (“Modified”: no release of the nasal floor or pterygoid

FIGURE 5. Intraoperative view of distractor in place across osteotomy site.

FIGURE 6. CT scan view after 4 months of consolidation. Note obvious calcification/healed bone at the pterygoid plate.

FIGURE 7. Clinical picture of the healed bone at the time of distractor removal.
plates.) This only gained 7 mm of the 12 mm he needed. This was not the appropriate technique, and thus failed at achieving advancement. We were then introduced to the RED device. Initially the RED device was used for 6 patients. This “modified” osteotomy was used initially, and although we had great anchorage off the skull, the distraction could not be accomplished. It was at this time that we realized that a complete Le Fort I osteotomy had to be used to get the maxilla advanced over such a long distance. The RED was the only maxillary distraction device available to us at that time.

The advent of the smaller internal devices enabled the evolution of our protocol to use distraction as a staging surgery. The team thus moved to using the internal bone-born devices. The internal devices have been used in 9 patients. The average movement in all cases was 15 mm of maxillary advancement. The range of movement was measured from 12 to 20 mm of movement. In all but 1 patient, excellent ossification occurred at the distraction bone as visualized at the time of distractor removal of the lateral maxillary walls (Fig 7).

Confirmation of ossification was confirmed prior to distraction removal with CT scan at 16 weeks’ consolidation. The patient with poor formation was an adult with a bilateral cleft lip and palate and very poor bone stock and difficulty in controlling the transverse torquing between the cleft segments. The patient required further bone grafting and placement of rigid fixation at the time of distractor removal. The patient has since healed without relapse.

In each case, long-term stable and predictable results have been achieved (Figs 8A,B). We have been following these patients now for 7 years. Of the skeletally mature patients, 4 went on to have formal Le Fort osteotomies at the time of distractor removal to establish a final occlusion. Four required surgically assisted palatal expansion secondarily at the time of distractor removal. The patients that were distracted during growth did not have any further maxillary growth. The maxillary position remained where we placed it at the end of distraction. These children have all eventually required formal jaw surgery. However, the movements of the second surgery were limited to small distances: no greater than 5 mm of anterior or posterior movement of the maxilla or mandible: predictable and stable. Report on the long-term outcome results will follow in the future.

References


