Mandibular & Maxillary Distraction Osteogenesis in the Treatment of Craniofacial Microsomia

In a typical mandibular distraction, anesthesia can be administered by either oral or nasal endotracheal intubation, but nasal intubation is preferred. The mandibular border is outlined on the skin surface with a surgical marker as a point of reference. Based on the patient's pathologic anatomy, the decision is made whether to use an intraoral or extra oral distraction device. Patients who require only unidirectional lengthening and have adequate mandibular bone stock are ideal candidates for intraoral distraction. Patients with severe mandibular deficiencies require distraction in multiple dimensions and are best treated with an extra oral device. In addition, patients who have previous external scars from other procedures are treated with an extra oral device. With an extra oral approach, care is taken not to damage soft tissue that may be needed for future surgeries, such as external ear remnants or microvascular soft tissue augmentation. Any incisions are placed in areas that can incorporate the distraction pins, so a second percutaneous pin site is unnecessary. An intraoral mucosal incision along the oblique line of the ramus is used for placement of both intra and extra oral devices.

In the initial clinical series, a supraperiosteal dissection of the mandible was recommended, following the Ilizarov tenant of minimal sub periosteal dissection. This maneuver is difficult to perform and has now proven unnecessary. Currently sub periosteal dissection is employed to elevate the entire lateral periosteal surface with a sharp-ended elevator. After the region of the osteotomy is exposed, the reciprocating saw is used to create lateral, anterior, and posterior corticotomies. The direction of the osteotomy is based solely on the bony pathology as well as the position of tooth follicles. The vector of the distraction is also a variable. Distraction can occur in the vertical, horizontal, or oblique vectors (based on the relationship of the vector to the long axis of the mandibular body). A vertical vector of distraction is preferred for lengthening a deficient ramus in a vertical dimension or for transporting the condyle up into the glenoid fossa. The horizontal vector along the long axis of the mandible is chosen in order to lengthen the mandible in a purely horizontal plane, as in bilateral micrognathias whose deficiency is predominately in the mandibular body. If an oblique vector (a direction between the vertical and horizontal vectors) is chosen, the osteotomy is placed anterior to the coronoid in order to prevent impingement of the coronoid on the zygomaticomaxillary buttress during distraction. An oblique distraction vector not only lengthens, but also vertically elongates the mandible.

Before converting the corticotomy into an osteotomy, the pins are placed. If the intraoral device is used, a single percutaneous stab incision is made for the placement of the screwdriver. For the extra oral device, a two-holed trocar is used for percutaneous placement of the posterior pins. The second anterior pair of pins is placed so that the skin between the two pin sites is compressed, thereby reducing the amount of tension

on the wound and the length of the scar. The device is attached to the pins. A 3 mm osteotome completes the medial wall osteotomy, liberating the mandibular segments for distraction. The wounds are closed in layers with absorbable sutures. A careful cleaning regimen is followed whereby the pin tracks are cleansed four times a day and, as needed for any blood or serous discharge with a dilute hydrogen peroxide solution. After a delay of 5 to 7 days (termed the latency period), distraction commences at a rate of 0.5 mm twice a day (termed the activation phase). This rate is continued until the mandibular length is overcorrected by several millimeters. During distraction, the vertical or oblique vector will typically become more horizontal, due to the counterclockwise pull of the muscles of mastication. At this time orthodontic intermaxillary elastics may be used to mold the regenerating bone and optimize the occlusion (termed molding the regenerate). The device is left in place to serve as an external fixator for 8 or more weeks, until there is radiographic evidence of mineralization. This stage is known as the consolidation phase.

In patients with unilateral craniofacial microsomia undergoing distraction, it is important that a dental impression be taken and a bite block placed in the surgically created posterior open bite when the device is removed. This will allow the orthodontist to level the maxillary occlusal plane by allowing for eruption of the ipsilateral maxillary dentoalveolar complex. Distraction will also affect the entire facial milieu: the soft tissue envelope bulk will increase due to a combination of soft tissue expansion and muscle hypertrophy and leveling of the oral commissure are usually noted.

Age is also a factor in developing a treatment plan. Under 2 years of age, mandibular distraction is not usually performed unless there is airway compromise. Soft tissue treatments such as cleft closure or preauricular skin tag removal are initiated. Cranial vault remodeling procedures are also performed at this age. Yet, mandibular surgery is avoided for several reasons. First, it is difficult to identify tooth buds at this age, and therefore permanent dental injury is a likely occurrence. Secondly, distraction at this age can be a daunting experience for the patient and the parents. The exception to this would be when early mandibular distraction is used to prevent tracheotomy in a newborn with micrognathia that is causing severe airway obstruction. We and others have successfully applied a modified distraction device to the infant pediatric mandible that distracts the bone at an increased rate of 2 mm/day and a decreased latency of 3 days. This relieves the airway obstruction within 10-14 days post-operatively, evading the need for early tracheostomy.

From ages 2-6 years mandibular distraction osteogenesis can be comfortably considered. Children with mild deformities, such as Pruzansky Type I mandibles and a horizontal occlusal plane should not be considered for distraction. However, orthodontic therapy can be initiated during this age period to maintain a level occlusal plane and prepare for the eventual osteotomies that will be required, using standard orthognathic techniques.

When a child presents with a more severe Pruzansky Type 1 or any Pruzansky Type 2 deformity, with associated sleep apnea (with or without a tracheostomy), distraction is initiated. It has been demonstrated that distraction will not only successfully expand the mandibular skeletal volume in all dimensions, but also positively augment the surrounding soft tissues and muscles of mastication. This is particularly important for patients with craniofacial microsomia who have a significant degree of soft tissue underdevelopment, in addition to a lack of mandibular growth. Distraction has the advantage over other techniques in that it requires minimal operative time, carries little risk, minimizes hospitalization time, obviates the need for blood transfusion, bone graft and intermaxillary fixation, and has minimal relapse rates. More importantly, decannulation of the tracheostomy is frequently feasible post-distraction. Parents should be warned that, if distraction occurs during this age interval, it is likely that a secondary distraction will be required following post-pubertal facial growth. It is unlikely that mandibular development will keep up with the growth of the remainder of the facial skeleton.

Children with Pruzansky Type 3 mandibular deformities (absent ramus, condyle, and/or glenoid fossa), are initially treated with an autogenous costochondral rib graft reconstruction at approximately 3-4 years of age (first stage). The costochondral graft will increase mandibular length, reconstruct the condyle, and form a pseudoarthrosis with the glenoid fossa. When the glenoid fossa is absent, a new one is constructed with rib grafts fixated to the zygomatic arch. In a second stage, at least 6 months after removal of the fixation, distraction of the rib graft can be performed. In rare cases, microvascular free tissue transfer is offered to create absent parts of the mandible. From age 6 to the teen years, during the period of mixed dentition, orthodontic treatment is needed to promote growth of the affected dentoalveolus and to aid in the proper eruption of the permanent teeth. Distraction would be considered during this time only if the patient had sleep apnea or never received any prior surgical treatment. Additionally, distraction could be performed if a patient has a significant growth deficiency in the mandible, after rib grafting.

Mandibular distraction during the teenage years should be postponed until the patient has reached skeletal maturity. In girls, this typically occurs at approximately age 15 and in boys at age 17. A wrist film is taken prior to any jaw surgery to confirm closure of the growth plates, signifying the end of endochondral bone development.

Indications for surgery in the teen years include: 1) residual post surgical skeletal deficiency due to surgical relapse or abnormal growth, 2) unsatisfactory bone contour, 3) malocclusion, or 4) absence of previous treatment. Any appropriately chosen maxillofacial surgical procedure could be performed during this time ranging from sagittal split osteotomies, to bone grafting, to distraction. In patients with minimal mandibular deformities, classic orthognathic procedures are indicated. Mandibular distraction should be considered in patients with moderate to severe skeletal deficiency, or bilateral disease, in where pressure from the soft tissues would significantly increase

the risk of postoperative graft resorption or skeletal relapse.

Restricted mandibular growth is frequently associated with abnormal maxillary development. The ipsilateral maxilla and dentoalveolar processes are often deficient in the vertical dimension. In mild cases this can be treated with a bite block and orthodontic therapy as described above; however, in more severe circumstances a maxillary (Le Fort I) leveling procedure may be considered. Traditionally, this has involved a Le Fort I osteotomy followed by ipsilateral lengthening of the mandible with bone grafts and a contralateral impaction.

The deficient maxilla can be distracted in conjunction with the mandible. In this technique, a Le Fort 1 corticotomy is made at the time of the mandibular osteotomy and placement of the distraction device. The upper and lower jaws are wired into intermaxillary fixation. After a 5-day latency period, distraction is commenced at the rate of 1 mm/day. At the conclusion of maxillary/mandibular distraction, the device is left in place for 8 weeks to allow for bone consolidation. Using this technique, we have had excellent soft tissue and bony results with complete leveling of the dental occlusion. Intermaxillary fixation is not employed during the latency period, instead heavy guiding elastics are placed at the time of distraction. The bands are modified throughout the process to obtain optimal dental alignment.

Maxillary deficiency is also addressed in a similar manner. We use KLS Martin, the Red external Maxillary distraction & internal distraction devices to correct Maxillary hypoplasia. These surgeries correct both the aesthetic appearance of the child and function problems such as sleep apnea.

Following the correction of the skeletal abnormalities, we will perform microsurgery to normalize the soft tissues in the face as well. Based on techniques developed by Ian Taylor in Australia and the staff at New York University, we can now significantly improve facial asymmetry by taking tissue from the back and moving it to the face. This augments the lack of soft tissue in the area. With these methods spectacular end results can be achieved for patients with craniofacial microsomia, Treacher Collins syndrome, Nager's syndrome, and Romberg's Hemifacial atrophy. This will be discussed further in the section on Romberg's disease.