Distraction osteogenesis (DO) is the process of bone formation that occurs during slow separation of the segments of bone after an osteotomy. Bone lengthening was first attempted in the early 1900s when Codivilla performed osteotomies and stretched femur bones. This practice remained dormant for several decades until Ilizarov revisited it in the 1950s by lengthening the limbs of patients living in the former Soviet Union. Ilizarov not only popularized the orthopedic treatment now known as DO but also invented the armamentarium used with DO techniques. McCarthy et al brought DO to a new frontier in 1992 when they used it to lengthen mandibles in children.

This cutting-edge technology, which is similar in concept to the rapid palatal expansion of the mid-palatal suture, can be applied in dentistry to lengthen mandibular-facial-calvarial bone. DO has been used to alleviate mandibular hypoplasia and asymmetries, hemifacial microsomia and Goldenhar’s syndrome, maxillary archwidth discrepancies, kleeblattschädel skull deformity, and severe midface deficiencies. In these situations, new bone has actually been generated in deficient areas to restore esthetics and physiologic function and to correct alterations in growth.

DO has recently been used in patients with hemifacial microsomia, which is characterized by unilateral facial hypoplasia, often with unilateral shortening of the mandible and subsequent malocclusion. In addition, a displaced ear lobule often is present, with diminished hearing on the ipsilateral side due to hypoplastic auditory structures. Embryologically, the first and second branchial arches, which contribute to ear formation, are affected. It is hypothesized that a hematoma in the area of the stapedial artery interferes with these branchial arches, thus causing hemifacial microsomia.

There are 3 types of hemifacial microsomia: type I is characterized by a shortened ramus height with an intact condyle and coronoid process; types IIA and IIB by a shortened ramus as well as some condylar disfigurement; and type III by a grossly distorted ramus with loss of identifiable landmarks or severe agenesis of the ramus and condyle.

**CLINICAL REPORT**

An 8-year-old child from the United Kingdom was seen at Providence Hospital, Southfield, Mich., with type IIB right-sided hemifacial microsomia, including a hypoplastic mandible and an inferiorly and anteriorly displaced ear lobule (Fig. 1). Normal growth of the unaffected side accentuated the deformity and shifted the mandibular midpoint toward the affected side. Panoramic radiographs revealed the degree of mandibular asymmetry. Further evaluation revealed an epibulbar cyst in the eye of the ipsilateral side, which indicated that the child had Goldenhar’s syndrome.

DO was initiated when the patient was 8 years old. The procedure included a small incision just above the angle of the mandible. The masseter muscle was severed at its insertion and reflected to gain access to the mandible. An osteotomy was performed at the ramus of the mandible, superior to the entrance of the inferior alveolar nerve into the mandibular canal. Conventional technique requires a distinct periosteal sleeve to remain intact for DO to occur. However, distraction has since been performed through an area of scar tissue in which native periosteum had been destroyed. In this treatment situation, the osteotomy extended through the periosteum, as well as bone. The surgical steel distraction device was secured onto both segments of the ramus with screws (Synthese Maxillofacial, Paoli, Pa.). The masseter was then repositioned, and the surgical site was left unsutured around the transcutaneous pin, which extended through the skin overlying the ramus (Fig. 2). The malposed ear lobule was removed at the time of surgery, and a faint scar unrelated to the distraction procedure formed in that area. The treatment plan included an autogenous ear graft or fabrication of an auricular prosthesis at a later date.

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Two weeks were allowed for healing. Subsequently, the patient’s parents activated the distraction device by rotating the transcutaneous pin with the aid of a handle attachment. The pin was rotated half a turn twice a day, yielding a distraction of 1 mm per day. The site was distracted a total of 12 mm over 12 days without relapse. The activated device in place and the amount of new bone gained are shown in Figure 3. The distraction device was left in place for an additional 8 weeks. This period allowed for new bone formation and stabilization of the area.

Gauze bandages were used to cover the area. The patient, who did not require any antibiotic therapy (topical or oral), reported that the procedure was painless and did not interrupt his daily activities. The patient was, however, instructed to decrease his physical activities (such as sports) so as not to disturb the transcutaneous pin. Mandibular movement remained relatively normal during the treatment procedure.

The final outcome of the distraction technique is shown in Figure 4. Improved symmetry was obtained in the mandible, and the occlusal plane was almost
leveled. Panoramic radiographs indicated the amount of new bone formed (Figs. 5-7). The patient will undergo orthodontic therapy to move the dentition into occlusion in harmony with the new mandibular position, which then will be stabilized. Prosthodontic methods of restoration may be indicated if some of the secondary dentition does not erupt or fails to develop.
DISCUSSION

Bone is formed in the area of the osteotomy by a tension-stress effect created by the distraction device.\(^3\) Parallel columns of bone are formed and extend from both edges to a central growth zone.\(^10\) The bone formed at 6 weeks has qualities of epiphyseal and intramembranous ossification.\(^11\)

DO has been known to relapse in some patients, meaning that the bone may regress slightly. Distracting the device slightly beyond the desired length can compensate for some regression. This procedure requires caregiver support and patient compliance during the 2 weeks in which the device is activated. DO is contraindicated in severe type III hemifacial microsomia (distorted ramus and loss of identifiable landmarks). This limitation is because of the severity of the deformity and lack of sufficient bone for distraction in the area.

Three advantages are associated with the use of DO in the mandible. First, this procedure requires only 1 surgical site. Conventional ramus graft surgeries, which are associated with increased morbidity, use iliac crestal bone as an autogenous graft and thus require 2 surgical sites. Second, newly formed bone can be distracted more than once so that, as the patient grows, additional distractions can be performed. In fact, the distraction device components may be left in place by simply removing the transcutaneous pin through the incision and reinserting it at a later date. Third, soft tissues in the area accommodate and stretch with the distraction device, and newly formed bone is of the same diameter and strength as the surrounding bone.

SUMMARY

DO is a remarkable way to improve deficiencies in bone development. The procedure can not only repair asymmetries and restore facial esthetics but also restore occlusion to a functional condition. For the patient described previously, DO resulted in improved symmetry in the mandible and a near-level occlusal plane.

REFERENCES


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