

CASE REPORT

Mandibular Distraction Osteogenesis with a New Ratchet Screw

R. SCOTT CONLEY, DMD
ARI Y. KRUG, DMD

Arch-length deficiencies have traditionally been resolved by interproximal reduction, extractions, or expansion.¹⁻⁴ In the mandibular arch, the only non-surgical option for transverse expansion has been to procline the teeth away from their bony support, which has been found to be unstable.⁵⁻⁸

Mandibular symphyseal distraction osteogenesis, using a midsagittal vertical osteotomy, is a recently developed technique that can achieve expansion of both the basal and alveolar bone.⁹⁻¹¹ Several orthodontic or surgical appliances are now available to adapt Ilizarov's distraction technique, originally de-

signed for long bones, to the craniofacial skeleton.¹²

Guerrero's appliance used a conventional rapid palatal expansion jackscrew, adapted to the lingual contours of the mandibular incisors and alveolus, for incremental distraction after callus formation in the midline osteotomy¹³ (Fig. 1). After this device was criticized for delivering more dental than skeletal expansion, a hybrid appliance was designed to apply more equal distraction forces (Fig. 2). Its superior arms, adapted to the mandibular canines or first premolars, apply transverse forces through the dentition, while the inferior arms are attached directly to the bone during surgery by means of monocortical screws.

Distraction osteogenesis appliances that attach only to the bone are also available (Fig. 3). Most have the advantage of activating with an audible and tactile click that can be observed by both the patient and the clinician. One drawback of such a device is that if the osteotomy is not complete at the superior aspect, the inferior skeletal expansion may be greater than the superior expansion. If this occurs, either the appliance will bind at some point



Fig. 1 Mandibular distraction osteogenesis appliance with conventional rapid palatal expansion jackscrew.



Fig. 2 Hybrid mandibular distraction osteogenesis appliance with both dental and osseous attachments.



Fig. 3 Bone-borne mandibular distraction osteogenesis appliance, attached with screws during surgery.



Dr. Conley



Dr. Krug

Dr. Conley is an Assistant Professor and Dr. Krug is a resident, Vanderbilt Orthodontic Center, 1500 21st Ave. S., Suite 3400, Nashville, TN 37212. E-mail Dr. Krug at ari.krug@vanderbilt.edu.

and not allow further expansion, or a controlled fracture may occur, releasing the segments to expand freely. In addition, because most bone-borne appliances remain entirely submerged beneath the mucosa, gingival dehiscence has occasionally been seen.

An appliance formerly used as a rapid palatal expander was recently modified to allow attachment directly to the mandibular bone.¹⁴ Its hex nut allows easy activation, and the device can be readily adapted to the mandible. Furthermore, its submucosal arms are less bulky than those of previous hybrid appliances, minimizing problems with gingival dehiscence.

Now, a similar appliance has been designed with a self-locking nickel titanium ratchet screw (Fig. 4). The toothborne RatchetRax* is made with .059" stainless steel arms that are adapted to the dentition, with rectangular guides that limit the wobbling observed with conventional jackscrews. Excessive wobbling motion can cause deactivation and lead to fibrous union or non-union of the distraction gap.¹⁵ The ratchet screw also prevents reverse turning due to interference by the tongue or lingual frenum. Therefore, the appliance does not have to be stabilized with a ligature wire or cement after the expansion is complete.¹⁶⁻¹⁸

The following case shows successful mandibular symphyseal distraction osteogenesis using the new ratchet screw design.

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Fig. 4 Toothborne mandibular distraction osteogenesis appliance with self-locking nickel titanium ratchet screw.

Diagnosis and Treatment Planning

A 15-year-old female presented with the chief complaint of crowding (Fig. 5). She had mild mandibular retrognathia, with moderate arch-length deficiencies in both arches. Her arches appeared narrow, and she showed dark buccal corridors when smiling. The patient and her mother both expressed dissatisfaction with her current smile width and dental display. Cephalometrically, she exhibited a Class I skeletal and dental malocclusion with mildly proclined maxillary and mandibular incisors.

The primary indication for mandibular symphyseal distraction osteogenesis is a “Brodie bite”, or a buccal crossbite in which the maxillary dentition completely telescopes the mandibular dentition. Another indication is a combination of a normal buccal overjet with narrow dental arches.^{11,14} Both conditions were present in this patient.

Two treatment options were offered. The first plan involved four first premolar extractions; the family was informed

that this was a traditional orthodontic treatment approach that would likely be the most stable, but would not augment the patient’s smile. The second possibility was bimaxillary expansion followed by nonextraction orthodontic treatment. The potential for trauma to the mandibular incisors and neurosensory deficit was discussed by both the orthodontist and oral surgeon. The family was advised that no neurosensory deficits have been observed to date—even in patients with less interradiolar bone than in this case—but that the chance does exist.¹⁹ The family chose the bimaxillary expansion treatment plan.

Expansion Procedures

Because the patient was not skeletally mature, conventional rapid palatal expansion was performed in the maxilla. If sufficient skeletal expansion had not been obtained, additional maxillary surgical expansion could have been performed at the same time as the mandibular surgery. In this case, the patient did not need surgical assistance after the rapid palatal expansion.

The self-locking ratchet screw described above was placed during the midsagittal mandibular osteotomy. The appliance was left passive during a one-week latency period to allow for callus formation.²⁰ It was then activated twice a day in .5mm increments. The patient experienced no problems with

partial or reverse turning of the screw.

After 7mm of mandibular expansion was achieved, the results were maintained by the ratchet screw without additional stabilization (Fig. 6). The appliance was left in place for three months, after which a lingual arch was used to retain the man-

dibular transverse dimension.

Treatment Completion

Sufficient space was generated by the mandibular expansion to allow treatment without extractions. The additional arch dimension was created within both the mandibular basal bone



Fig. 5 15-year-old female patient with chief complaints of crowding and dark buccal corridors.

and the alveolus. As a result, the dentition was not tipped or expanded beyond its bony support (Fig. 7).

Discussion

The rotation that is postulated²¹ and the translation that

has been demonstrated²² in mandibular distraction osteogenesis do not seem to have had any negative long-term effects on the TMJ. Some mild, transient TMJ discomfort has occasionally been observed near the end of distraction. The level of discomfort is reported by patients as



Fig. 6 Patient after 7mm of mandibular expansion with Ratchet-Rax, before osseous consolidation.



Fig. 7 Patient after 19 months of nonextraction orthodontic treatment, showing fuller, more esthetic smile and teeth in ideal axial inclinations, well positioned over supporting alveolar and basal bones.

being similar to what is experienced in the early stages of rapid palatal expansion, and it seems to resolve in a short time with the use of only over-the-counter anti-inflammatory medication.

Because craniofacial distraction osteogenesis is still in its infancy—much like orthognathic surgery in the 1960s and 1970s—further study is needed to substantiate its occlusal, skeletal, and periodontal stability. In the one report published to date, the follow-up was only a little more than one year post-surgery, and more than half of the patients still had orthodontic appliances in place.²³

Conclusion

As shown in this patient, mandibular symphyseal distraction osteogenesis expands the mandibular arch while maintaining appropriate axial inclinations of the teeth. A self-locking ratchet screw prevents reverse turning and provides positive tactile and auditory evidence of a complete activation, thus improving patient compliance. Since the present case was completed, the manufacturer has reduced the size of the screw for a better fit between the mandibular canines, and the ratchet has been fully enclosed to reduce food collection and minimize the risk of appliance failure.

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