CASE REPORT

A Simple Technique for Mandibular Symphyseal Distraction Osteogenesis

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Various methods have been developed for mandibular arch expansion,[1] including Schwarz plates,[2] lip bumpers,[3-5] lingual arches, functional appliances,[6,7] and archwires. Each of these provides limited dimensional change, with questionable long-term stability.[8-10]

Distraction osteogenesis is a process by which bony segments are gradually separated with increasing traction.[11] The resulting tension on the skeletal and surrounding soft-tissue structures ultimately results in the formation of new bone between the segments, parallel to the vector of distraction.[12] This process was originally developed for substantial lengthening of the limb bones,[11-13] but has been successfully adapted to modify the anteroposterior position of the jaws.[14,15]

Mandibular symphyseal distraction osteogenesis (MSDO) can increase the transverse dimension of the basal mandibular bone. Unlike functional appliances, which affect only the alveolar bone, MSDO alters the functional matrix and tone of buccal musculatures. Although it should therefore result in better long-term stability,[16,17] the technique has not yet been evaluated in sufficient numbers of patients,[18-20] nor has its long-term impact on the TMJ or the incidence of gingival recession in adjacent teeth been studied.

This report describes the successful correction of bimaxillary dentoalveolar protrusion by means of MSDO combined with rapid palatal expansion (RPE) using a new, simplified mandibular expander.

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Diagnosis

A 13-year-old female was referred for orthodontic treatment with the chief complaint of protruding teeth and lips. Clinical examination showed a Class II, division 1 malocclusion associated with a retrognathic mandible (Fig. 1). Mild remodeling of both TMJs was evident, but there were no clinical symptoms. Although the teeth were not substantially misaligned, the patient had a significant tooth-mass/arch-length discrepancy that caused bimaxillary dentoalveolar protrusion and thus an unesthetic lip incompetence. The airway was constricted in the hypoglossal, retroglossal, and retropalatal areas, with a Mallampati score of 3.[21]

Treatment Progress

Self-ligating appliances (GAC In-Ovation R*) were bonded to level and align the lower molars, premolars, and canines, preparing anchorage for MSDO. After 12 weeks of treatment, upper and lower expanders were placed.

The next day, the patient underwent MSDO under local anesthesia and light intravenous sedation. The surgical cut consisted of a simple mucoperiosteal incision at the symphyseal area,

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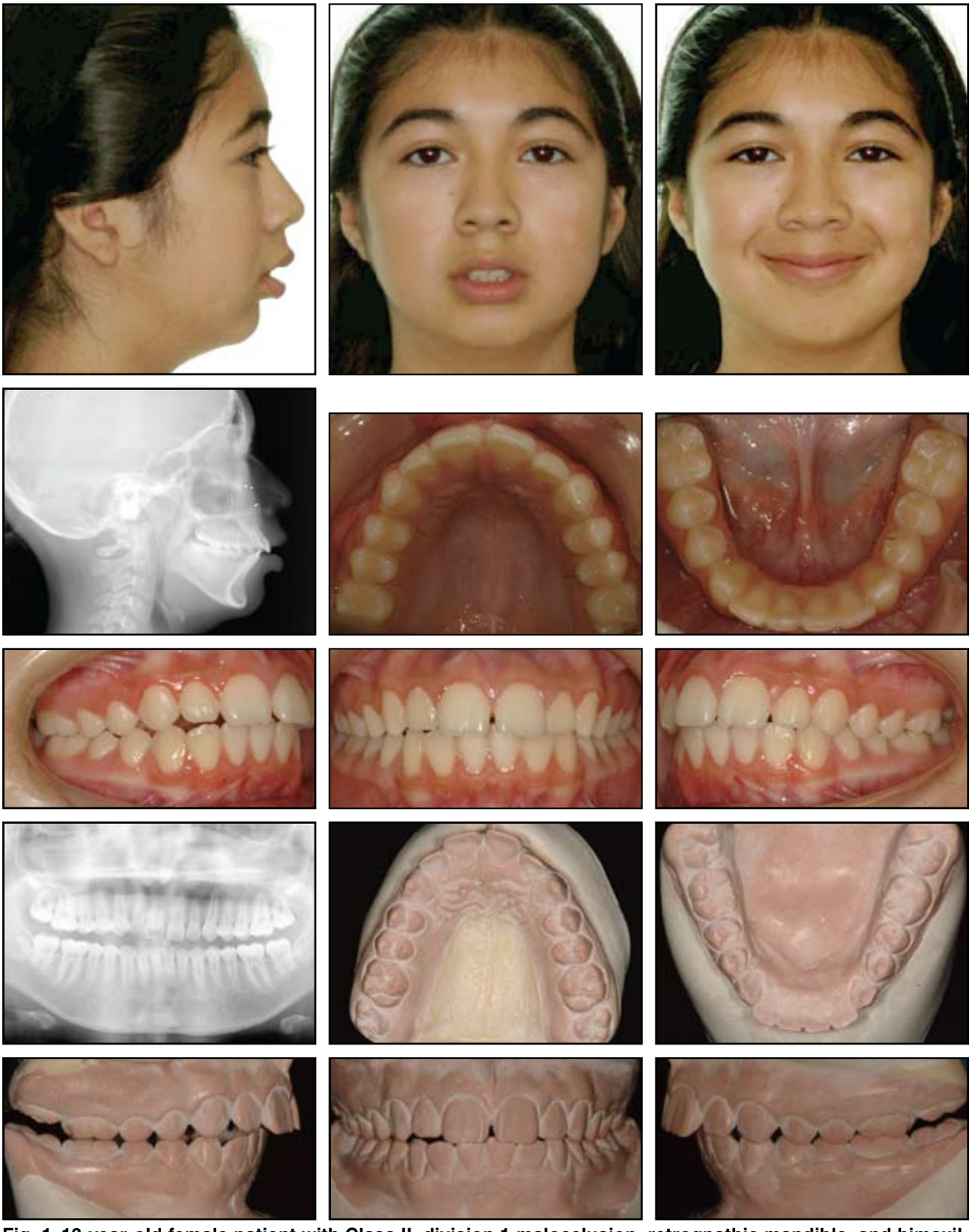

Fig. 1 13-year-old female patient with Class II, division 1 malocclusion, retrognathic mandible, and bimaxillary dentoalveolar protrusion before treatment; cephalometric radiograph was taken with mandible in centric relation (CR), and casts were mounted in CR.

Fig. 2 Records taken during mandibular symphyseal distraction osteogenesis (MSDO) and rapid palatal expansion (RPE).

5mm below the mucogingival junction. The flap was extended to expose the subsymphyseal bony anatomy. A pneumatic jigsaw was then used to make a cut from the lower border of the mandibular symphysis, extending 5mm short of the apical roots of the lower central incisors. Using an osteotome wedged into the bony cut and a torquing motion, the osteotomy was extended between the roots of the central incisors, avoiding potential damage to the periodontium from the jigsaw. The attached and unattached gingival tissues and interradicular fibers were not disturbed. The incision was closed with self-absorbing sutures.

Initial expansion was performed at the surgeon's office with a quarter-turn (.25mm) activation of the mandibular expander. The mandibular symphyseal expansion protocol consisted of one turn every other day for the next four days. Both maxillary and mandibular expanders were then activated twice a day for two weeks, producing .5mm of widening per day and a total expansion of 8mm. The upper and lower central and lateral incisors were allowed to drift toward one another and into the distraction sites by means of intact transseptal fibers (Figs. 2,3).

Mandibular widening was performed with a simplified expander, designed by the author, that was attached to the lower first premolars. During the eight weeks of expansion, the patient experienced no TMJ symptoms or discomfort. Orthodontic treatment was completed in 24 months.

Treatment Results

This expansion technique, combined with the maxillary RPE, provided the space needed to resolve the tooth-mass/arch-length discrepancy, align the dentition, and correct the excessive proclination of the upper and lower anterior teeth (Fig. 4). The larger oral and pharyngeal spaces also facilitated anterior repositioning of the tongue, thus relieving the upper-airway constriction. After appliance removal, proper cusp shapes and occlusion were achieved through comprehensive equilibration, without the need for restorations. Well-intercuspated Class I molar and canine relationships were attained, with increased maxillary and mandibular basal transverse dimensions and a balanced facial profile.

Discussion

Conventional approaches to correcting mandibular crowding include extraction of the upper and lower first or second premolars; dentoalveolar expansion and/or protrusion; and reduction of interproximal enamel.[22-24] Although these treatment approaches can be effective, long-term results are unpredictable, sometimes involving relapse and undesirable side effects.[8]

When closing extraction spaces, improper anchorage preparation can result in constricted dental arches and overretraction of the anterior teeth. Making already-constricted dental arches narrower can generate symptoms and complications of upper-airway constriction[25]; it can also impair facial and dental esthetics by retracting the lips and producing "black corridors" in the corners of the smile.[26-30] This effect might have been even more accentuated in the patient shown here, considering that the hyperactive elevator muscle function at the corners of her mouth caused

unusually broad stretching of the lip commissures during smiling (Fig. 4).

In this case, the use of conventional RPE and a new, simplified MSDO technique produced significant bimaxillary transverse expansion. With adequate oral volume to bring the base of the tongue forward from the posterior pharyngeal wall, the oropharynx was opened up. The expansion also augmented the nasopharyngeal, oropharyngeal, and nasal-cavity volumes, which should greatly reduce resistance to nasal airflow.[31] If the airway is considered a simple tube, then as its radius increases, resistance to airflow should decrease exponentially (resistance = $8L\eta/\pi r^4$).[32]

Among the various types of expanders, toothborne appliances are the least expensive, the easiest to install and replace, and the least likely to promote infection. On the other hand, these appliances also produce tongue discomfort, speech impediment, and negative effects on the TMJs. In previous studies, both toothborne and boneborne expanders have been shown to displace the mandibular condyle linearly, regardless of the distractor used,[18,33] because of the rigidity of the distraction appliances and their attachments to the mandible.[33,34] For the condyles to be displaced

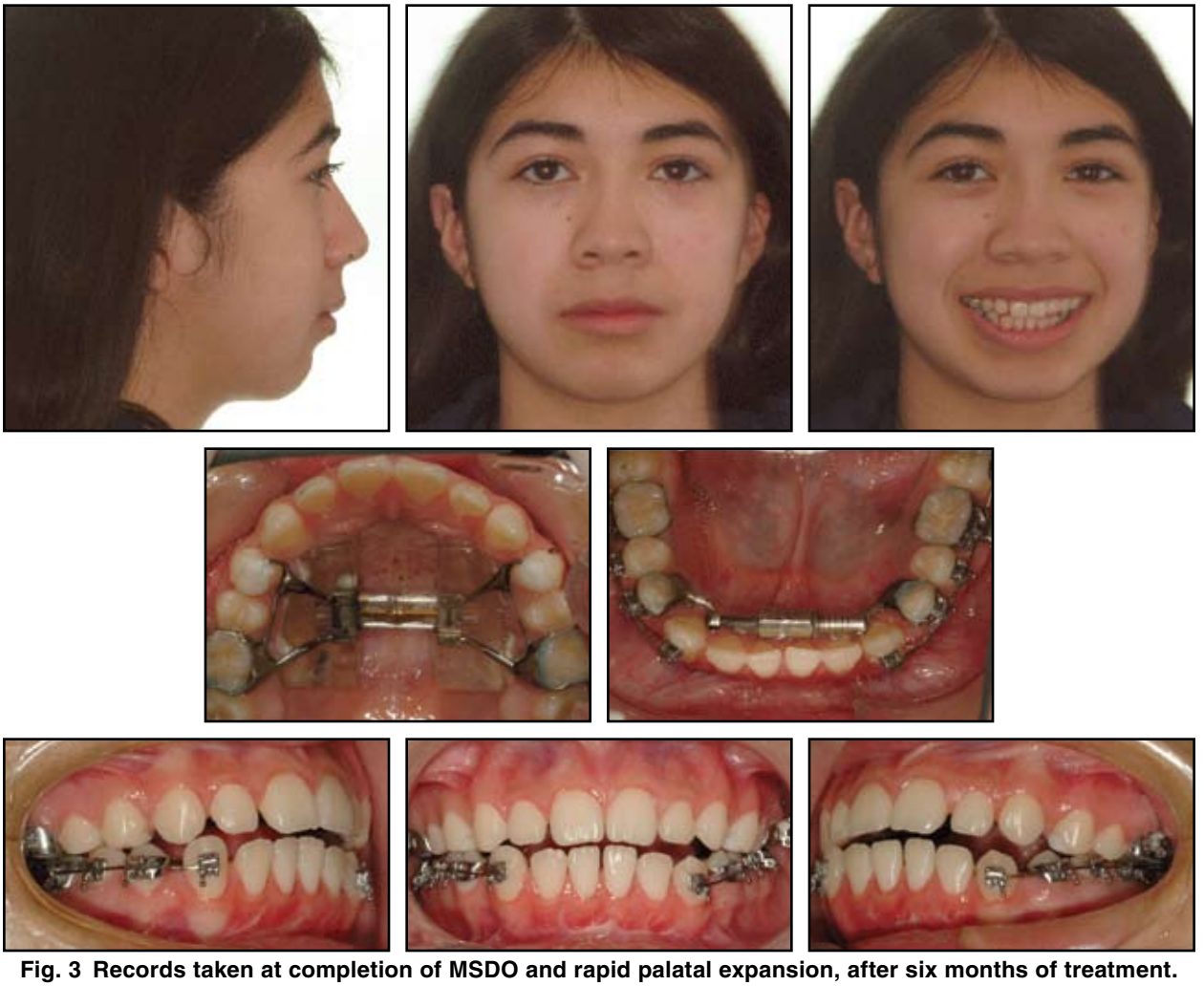

Fig. 3 Records taken at completion of MSDO and rapid palatal expansion, after six months of treatment.

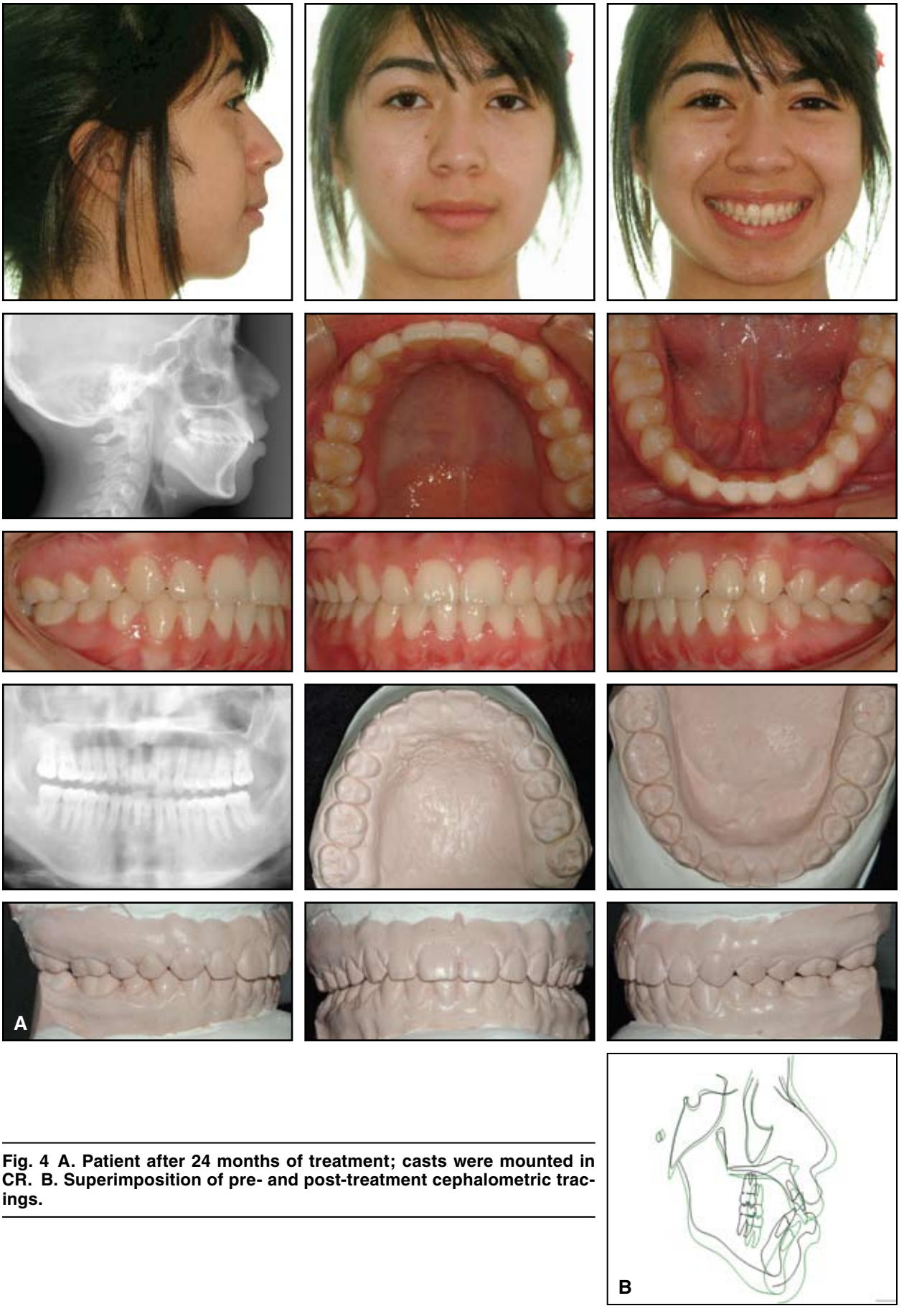

Fig. 4 A. Patient after 24 months of treatment; casts were mounted in CR. B. Superimposition of pre- and post-treatment cephalometric tracings.

Fig. 5 Impact of distraction by new toothborne mandibular distractor on condyles. A. Mid-distraction stage with stabilized appliance, showing position of attachment arms. B. Predistraction stage with stabilized appliance. C. Post-distraction stage, showing anterior expansion (green arrows) caused by distraction of mandibular halves. Yellow-red arrows indicate favorable vectors of condylar rotation, with minimal lateral displacement. Blue arrows show compensatory rotations at root-socket interfaces of first premolars.

angularly, as some have proposed, the ramus and posterior portions of the mandibular body would have to undergo complex, compound bending.[32,35-37] Measurements from recent studies have shown that muscular and soft-tissue attachments to the mandible do not bend the jaw in this manner.[33]

Condylar displacement can be more severe with expanders that use the molars and first premolars as anchorage attachments[18] and less so with expanders that are extended only to the first or second molars. When the arms of a toothborne expander are attached to the mandibular first premolars and molars, the condyles typically are displaced laterally and linearly, in proportion to the amount of symphyseal distraction.[33] Even boneborne expanders have a tendency to displace the condyles laterally,[34] since their unhinged, inflexible design connects the two halves of the mandible at the symphysis by means of multiple long, rigid screws.

In patients I have treated with this simple MSDO technique, including the case reported here, comparisons of pre- and post-treatment dental casts have shown the greatest increases in the lower premolar and intercanine widths. The widening effect gradually decreases toward the distal. The two halves of the mandible rotate in a nonparallel, wedge-shaped fashion on the occlusal plane, centered on the vertical axes of the respective condyles. There is little to no lateral condylar displacement because of compensatory rotation at the root-socket interfaces of the first premolars (Fig. 5). This phenomenon is facilitated by the round cross-section of the root-socket interface and the lack of rigidity of the wire attachment to the premolar bracket slot. Although mandibular canines are preferred over the first premolars in terms of logistics and strength, they are less desirable for anchorage in this technique because of the dumbbell-shaped cross-section of their roots.

The vertical position of the expansion screw is critical in ensuring proper parallel distraction of the mandibular halves and ideal rotation of the condyles around their vertical axes. The optimal position appears to be at the level of, or 1-2mm below, the cementoenamel junctions of the incisors (Fig. 2). Higher positioning can cause greater separation at the incisal edges, with little to no distraction of the bony edges at the lower mandibular border, and would also displace the condyles laterally, with constriction at the gonial angles. On the other hand, lower-than-optimal positioning of the expansion screw will increase distraction at the lower mandibular border, with little or no separation at the incisal edges, and create expansion at the gonial angles, with medial condylar displacement.

Conclusion

The simple, modified expander design and outpatient MSDO technique presented in this article can be a useful method of resolving mandibular constriction and resultant crowding. Investigation in a larger population of patients is required to further delineate the benefits and risks of this apparatus.

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