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Mandibular Symphyseal Distraction and Its Geometrical Evaluation: Report of a Case

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ABSTRACT

In this report, the case of a patient who has been treated with a different use of a tooth-borne custom-made mandibular symphyseal distraction device is presented. The difference in the application is that the distal arm of the device was sectioned during the retention phase to allow the possible relapse of displaced condyles to their original positions while the labial segment expansion is being maintained. The effect of this procedure was also evaluated on a geometrical model using measurements from the patient's cast. We conclude that symphyseal distraction is an effective and fast method of correcting orthodontic anomalies. The effect of the procedure on the condyle was only 3° of distolateral rotation as calculated using the geometrical model.

KEY WORDS: Mandibular symphyseal midline distraction, Distraction osteogenesis, Condyle rotation, Geometric model.

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INTRODUCTION [Return to TOC](#)

Transverse skeletal deficiency is a common clinical problem associated with narrow basal and dentoalveolar bone. In comparison with maxillary deficiencies, diagnosis and treatment of mandibular transverse discrepancies have received little attention.^{1,2} Posterior buccal crossbites and crowding are commonly used as clinical indicators of transverse mandibular deficiency.³

Attention to the transverse deficiencies is vital in planning treatment for a patient who requires an increase in the lateral dimension of the mandible or maxilla. Treatment options include compensating orthodontics, functional appliances, and orthopedic devices.

Transverse mandibular deficiencies in mix dentition stage are commonly treated with orthodontic expansion using lip bumpers, Schwarz's device, or functional devices. These therapies show relatively stable results for younger patients, particularly those who presented with lingually tipped teeth that need to be decompensated.⁴ But expansion in all the patients or expansion in the anterior area is unstable and tends to relapse toward the original dimension and with a compromised periodontium created by moving teeth out of their supporting alveolar bone.⁶

In adult patients, symphyseal osteotomy has been proposed as a solution for correction of transverse mandibular deficiencies.

Symphyseal mandibular osteotomies, however, have not been well accepted perhaps because of the risk of periodontal problems that may occur when the bone segments are rapidly and excessively separated.³

Distraction osteogenesis (DO) is a biologic process of new bone formation between bone segments that are gradually separated by incremental traction. DO holds great potential for correcting transverse mandibular deficiencies. Guerrero pioneered the use of rapid surgical mandibular expansion to correct mandibular transverse discrepancies. Santo et al³ later showed that mandibular symphyseal DO, using both tooth-borne and bone-borne expansion devices, provides an efficient surgical alternative to orthognathic surgery for the treatment of transverse deficiencies. Transverse mandibular DO involves moving the osteotomized segments of the mandible in either a varus or a valgus direction.⁷


Today, mandibular transverse deficiency is a skeletal deformity with a predictable treatment solution—surgically assisted expansion by DO without the need for extraction or compromised esthetic, functional, or periodontal results.^{8,9}

Samchukov et al¹⁰ have carried out theoretical studies that demonstrate and predict changes associated with symphyseal DO. These authors concluded that biomechanical principles must be applied when planning the treatment for DO. In the study of Samchukov et al, incremental midline mandibular widening showed a proportional increase in the transverse rotation angle of the mandible measured at the condyle.¹⁰

The aim of this article was to present a case in which a patient was treated with symphyseal distraction and rapid maxillary expansion (RME) followed by full arch fixed appliance therapy. The effects of DO are also evaluated geometrically.

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Diagnosis

A 17-year-old boy was referred to our department with a chief complaint of crowding in the upper and lower jaws. Clinical examination of the patient revealed a Class I molar and canine relationship with 12 in crossbite and 90° mesiolingual rotation of 41. The growth pattern was vertical, with an open-bite tendency ([Figure 1](#) ). The space deficiency was 9.5 mm in the maxilla and 6 mm in the mandible. The treatment plan included symphyseal distraction of the mandible and rapid expansion of the maxilla followed by fixed appliance therapy.

Treatment objectives


The objectives of orthodontic treatment were

1. Maintenance of Class I molar and canine relationship.
2. Space preparation for lower-arch crowding with symphyseal DO.
3. Space preparation for upper-arch crowding with RME.
4. Alignment of the upper and lower arches with fixed mechanics.

Treatment alternatives

The two treatment alternatives for this case were (1) extraction of all of the first premolars, or (2) mandibular symphyseal distraction followed by RME and fixed mechanics.

Treatment progress

Symphyseal distraction. A distraction device was constructed using a GAC 13 mm Hyrax screw. The lower legs of the screw were cut off to ease accommodation and placement of the screw in the lingual area. The lower 4s and 6s were banded, and the remaining arms of the screw were adjusted and soldered to the premolar and molar bands ([Figure 2](#) ).

Next day, after the cementation of the appliance, a bicortical osteotomy of the symphyseal region was performed under local anesthesia with intravenous sedation. After completion of the osteotomy, the screw was activated 12 turns, ie, 3 mm, and deactivated. The latency period was five days, and the appliance was activated first by the orthodontist 0.5 mm. The patient was instructed to activate the screw four turns (total, 1 mm) a day (two in the mornings and two in the evenings). The active distraction period lasted one week and yielded an expansion of 7 mm. The amount of expansion was equal at the first premolar and first molar levels, ie, 3 mm on each side.

Ten days after the completion of the activation period, the lower arch was bonded, and tooth movement into the distraction site was

initiated. About one month later, the rigid arms of the screw were sectioned distal to the premolar bands to allow for possible relapse of the posterior mandible (Figure 3). This resulted in a two-mm relapse of molar-to-molar measurement. One week later, maxillary expansion was initiated with a bonded acrylic RME appliance. After an expansion period of four weeks, the appliance was left in place for retention. After removal of the appliance, the upper arch was also fully bonded, and expansion was retained with a transpalatal arch. The arches were leveled in three months. The retaining distraction screw was removed at this stage, 90 days after completion of distraction.

Results achieved

The occlusion was detailed, and the case was finished 10 months after initiation of the treatment (Figure 4). A functional Class I occlusion with good overbite and overjet was achieved. The upper and lower crowding was resolved.

Cephalometric analysis showed that the angulations of the maxillary and mandibular incisors remained relatively unchanged. But the lower incisors were slightly proclined in relation to their skeletal components. The open bite was corrected by a slight extrusion and uprighting of the upper incisors (Figure 5; Table 1).

GEOMETRICAL EVALUATION OF SYMPHYSEAL DISTRACTION [Return to TOC](#)

Records of this patient were also used to geometrically evaluate the effects of the distraction process on the condyle. The distractor used was anchored bilaterally to the lower 4s and 6s. The arms of the distraction screw were 1.5 mm in diameter. Before initiation of distraction, the 4-to-4 and 6-to-6 distances were measured on dental casts. The distance between the 4s and the head of the condyle was measured directly on the patient by digitations of the lateral pole of the condyle (Figure 6A).

A symphyseal distraction of six mm was carried out with the rigid appliance (Figure 6B). The cast measurements of 4-to-4 and 6-to-6 were as shown in Figure 5. Direct measurement of these distances confirmed that the rigid appliance caused a parallel movement of the semimandibles. But because the condylar area was not accessible, the same amount of expansion was assumed to take place in this area, thus leading to three-mm lateral displacement of the condylar heads on both sides (Figure 6).

After completion of distraction, in the retention period, the rigid arms connecting the 4s to the 6s were sectioned just distal to the 4s to allow possible relapse of the distal segment of the mandible to its original position (Figure 6C). The aforementioned measurements were repeated one week later. The 4-to-4 dimension remained unchanged, whereas the 6-to-6 measurement decreased by 1 mm on each side (Figure 6D). At this point, a triangle was formed using the cast measurements to calculate the amount of relapse in the condylar heads. The premolar point formed the apex of the triangle, which was stable between two measurements (A in Figure 7). The right arm of the triangle represented the after-distraction position of the 4-to-condyle line (A-E in Figure 7). The left arm represented the after-sectioning position of the same line (A-D in Figure 7). A line D-E, which represented the relapse path of the condylar head after sectioning of the distraction appliance, formed the base of the triangle. According to the measurements, the distance between the after-distraction and relapsed first molar points, which were 30-mm distant from the apex, was one mm for each side (B-C). The total height of the triangle was 90 mm. Thus, according to the mathematical rules, the length of the base of the triangle (D-E) should be three times the 6-to-6 distance (3 mm) because it is three times distant from the apex (Figure 7). The distolateral rotations of the heads of the condyles were measured on 1:1 geometrical drawings and were measured as 3° (Figure 8).

DISCUSSION [Return to TOC](#)

Alterations in the temporomandibular joint (TMJ) and possible joint symptoms have been concerns after mandibular midline DO. Samchukov¹⁰ et al demonstrated lateral rotational movement of the condyles after mandibular midline expansion by using computer simulation. They showed that one mm of mandibular widening produced 0.34° of rotation of each mandibular condyle. Our study showed that a distolateral rotation of the heads of the condyles is 3° for six mm expansion. Finally, one mm of mandibular expansion produced 0.5° of rotation of each mandibular condyle. Our study results are in accordance with that of Samchukov's. But this result of course should be used with caution because it is achieved through indirect calculation of an area that is inaccessible and hardly reproducible with imaging techniques.

What is the effect of this amount of rotation on the TMJ? This topic still has been discussed in literature. Bell et al¹¹ studied the histological changes in the mandibular condyle after mandibular symphyseal DO. They believed that the observed changes in the condyles were minor.

Mommaerts et al¹² think that moderate symphyseal expansion will not cause clinical problems in the TMJ area. For years, unilateral sagittal splits have been used to correct laterognathic mandibles without having detrimental effects on TMJ function. Kewitt and Van Sickels⁹ suggested that mandibular symphyseal DO can be performed with limited morbidity.

Samchukov et al,¹⁰ however, considered that this rotation should be compensated. They believed that this rotation, if not compensated, could create inappropriate loading on the articular surface of the condyle and subsequent degenerative condylar changes. They suggested

that two possible biomechanical solutions might be considered as condylar rotation. The first is a combination of mandibular widening with condylotomy. The second solution is the incorporation of a hinge in the distraction appliance, in addition to ramus osteotomies, so that the inappropriate rotation of condyles during widening is prevented.

In our patient, no TMJ symptoms and dysfunctions were found clinically, and no signs of articular disk displacement were detected on TMJ magnetic resonance imaging (MRI). An additional question arose from this study: What are the functional disabilities in the TMJ caused by movements that induce significant damage? Future prospective longitudinal studies are necessary to precisely evaluate distraction and postdistraction TMJ changes. For this purpose, MRI, computerized tomography, and clinical functional TMJ examinations should be incorporated into the study design. The amount of distraction in the bone segments should be measured with bone markers. Lateral, submentovertebral, and posteroanterior radiographs should also be used for three-dimensional assessment of mandibular symphyseal DO in future studies.

This case report presented a patient whose treatment plan included symphyseal DO. There were several factors that led to the decision of symphyseal DO in this case. From the orthodontist's point of view, the maxillary arch should be expanded, and this was limited by the already completed transverse growth of the mandible. Lower expansion would preserve the mandibular intercanine transverse harmony with the maxilla while providing enough space for the rotated incisor, all without the need for extractions. Moreover, the patient and his parents refused extractions because the family was being appointed to another location within a year.

Consequently, we conclude that symphyseal DO offers an alternative treatment strategy to resolve crowding and transverse mandibular deficiencies in a short period of time with little effect on the condyle. But long-term results with larger samples are required to draw generalized conclusions.

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TABLE 1. Subject's Cephalometric Values Throughout Treatment

	Before Treatment	After DO ^a	After Treatment
SNA (°)	82	82	83
SNB (°)	80	78	80
ANB (°)	2	4	2
U1-PP (°)	120	120	122
U1-NA (°)	11	11	12
IMPA (°)	91	93	93
L1-NB (mm)	8	9	9
G0-Gn-SN (°)	38	38	37
A-Pg (mm)	84	84	83
UL-E (mm)	0	-1	-2
LL-E (mm)	3	3	3

^a DO indicates distraction osteogenesis.

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Click on thumbnail for full-sized image.

FIGURE 1. Pretreatment photographs



Click on thumbnail for full-sized image.

FIGURE 2. Distraction site



Click on thumbnail for full-sized image.

FIGURE 3. Arms of the screw sectioned posterior to the 4s



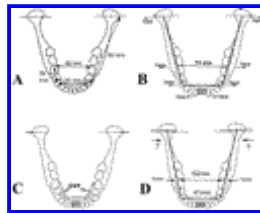
Click on thumbnail for full-sized image.

FIGURE 4. Posttreatment photographs



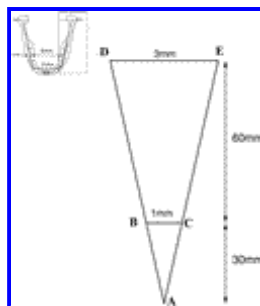
Click on thumbnail for full-sized image.

FIGURE 5. Superimposition of pretreatment, postdistraction, and posttreatment radiographs. Black, pretreatment; dashed, after distraction; blue, posttreatment



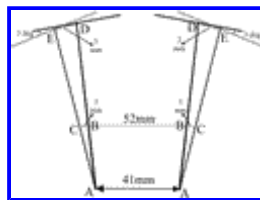
Click on thumbnail for full-sized image.

FIGURE 6. (A) Dental cast and 4-to-condyle measurements before distraction. (B) Dental cast measurements after distraction (note that increases in the 4-to-4 and 6-to-6 distances are equal). (C) Arms of the screw are sectioned in the retention period. (D) Cast measurement after sectioning of the screw shows one-mm relapse of 6-to-6 measurement on each side. Figure 6 is adapted from Samchukov ML, Cope JB, Harper RP, Ross JD. Biomechanical considerations of mandibular lengthening and widening by gradual distraction using a computer model. *J Oral Maxillofacial Surgery*. 1998;56:51–59. Figures 2 and 5, p 53, 55



Click on thumbnail for full-sized image.

FIGURE 7. After relapse, a geometrical model is formed using the cast measurements to calculate the relapse of the condyle. A is the first bicuspid point, BC is the relapse path of first molar point, and DE is the relapse path of the condyle. Figure 7 is adapted from Samchukov ML, Cope JB, Harper RP, Ross JD. Biomechanical considerations of mandibular lengthening and widening by gradual distraction using a computer model. *J Oral Maxillofacial Surgery*. 1998;56:51–59. Figures 2 and 5, p 53, 55



Click on thumbnail for full-sized image.

FIGURE 8. The theoretical resultant change in the condyle after distraction is 3° of distolateral rotation of the condylar heads as measured on the geometrical model

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