The Online ANGLE ORTHODONTIST
An International Journal of Orthodontics and Dentofacial Orthopedics
78th Anniversary 1930-2008

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doi: 10.2319/111907-539.1
The Angle Orthodontist: **Vol. 78, No. 6, pp. 1125–1132.**

Orthodontic Treatment Combined with Mandibular Distraction Osteogenesis and Changes in Stomatognathic Function

Aya Maeda;[a] Kazuhisa Soejima;[b] Mikinori Ogura;[c] Haruhito Ohmure;[a] Kazumasa Sugihara;[d] Shouichi Miyawaki[e]

ABSTRACT

We performed an orthodontic treatment combined with mandibular distraction osteogenesis in a 15-year-old patient who wanted a correction of a chin deficiency and a protruding upper lip. The patient had an Angle Class II division 1 malocclusion with mandibular retrusion, a low mandibular plane angle, and scissors bite. First, a quad-helix appliance was applied to the mandibular dentition to correct the scissors bite in the bilateral premolar region. Later, a preadjusted edgewise appliance was applied to the maxillary and mandibular teeth. After 3 days, a mandibular distraction osteogenesis was performed. During and after the distraction, the open bite between the upper and lower dental arches was corrected using up and down elastics. The total treatment time with the edgewise appliance was 14 months. A skeletal Class I apical base relationship, good facial profile, and optimum intercuspation of the teeth were achieved with the treatment. The jaw-movement pattern on the frontal view did not change during gum chewing. However, the maximum gap without pain increased. The electromyographic (EMG) activity of the masseter and anterior temporalis muscles, and maximum occlusal force increased. The present case report suggests that an orthodontic treatment combined with mandibular distraction osteogenesis in a patient with mandibular retrusion in the late growth period might be effective for improving stomatognathic function.

KEY WORDS: Distraction, EMG, Occlusal force, Stomatognathic function.

Accepted: January 2008. Submitted: November 2007

INTRODUCTION Return to TOC

In patients with skeletal Class II malocclusion and mandibular retrusion after a growth spurt, two alternative treatment methods are available; camouflage orthodontic treatment such as extraction case and surgical orthodontic treatment such as mandibular advancement surgery. Camouflage orthodontic treatment provides dental compensation without resolving the skeletal problem. Although mandibular advancement surgery is surgically invasive, it can resolve the skeletal disharmonies.[1–6] Bilateral sagittal split osteotomy[1–3] and mandibular distraction osteogenesis are frequently used as mandibular advancement surgeries.[4–6]

Mandibular advancement with a bilateral sagittal split osteotomy exceeding 7 mm is not recommended because postoperative skeletal relapse[7–9] and condylar resorption[10–12] often occur. When compared with the bilateral sagittal split osteotomy, mandibular advancement with a distraction osteogenesis exceeding 7 mm has several advantages: less postoperative skeletal relapse due to the relatively slow expansion of the soft tissue complex,[13–15] less progressive condylar resorption,[13–16] and less inferior alveolar nerve damage.[17] Mandibular distraction osteogenesis is often applied to nonsyndromic patients who are 11–17 years old[13] because of the high potential for bony regeneration.[4–6,18] Mandibular distraction osteogenesis in particular was reported to be effective in patients with an average to low mandibular angle in a skeletal Class II malocclusion.[19–21]

It has been reported that patients with a mandibular retrusion show a low maximum electromyographic (EMG) activity and weak maximum occlusal force during clenching and mastication.[22–25] Many reports have examined stomatognathic function after orthodontic treatment, including bilateral sagittal split osteotomy in patients with malocclusion.[22,25,26–29] Some cases with skeletal Class II had improved stomatognathic function,[23,25] but other cases were unchanged or worse after orthognathic surgery.[23,25,26] However, there have been few reports in which the changes of stomatognathic function were examined after mandibular distraction osteogenesis in patients with mandibular retrusion and Class II malocclusion. This article demonstrates the successful treatment of, and change in, the stomatognathic function after mandibular distraction osteogenesis in such a patient.

CASE REPORT Return to TOC

Case Summary

The patient was a 15-year-old boy with a chief complaint of chin deficiency and protruding upper lip. No signs or symptoms of temporomandibular joint disorders (TMD) were noted.

His facial profile was a convex type with chin deficiency, a deep mentolabial sulcus, and protrusive upper lip (Figure 1a,b). The patient had an Angle Class II division 1 malocclusion with excessive overjet, a severe deep bite, scissors bite in the premolars, a lower constricted dental arch, and an upper spaced arch (Figure 2a–f).

The lateral cephalometric analysis indicated a skeletal Class II jaw relationship with an ANB angle of 7.0° and a severe short face with a mandibular plane angle of 12.0° and gonial angle of 107.5°. The maxillary incisor was protruded with a maxillary central incisor to the Frankfort plane angle (U1-FH angle) of 124.5°. According to the soft tissue analysis, lower facial height was short with subnasale-Gn of 59.5 mm and middle third height/lower third height (G-Sn/Sn-Me) of 1.2. A protruding upper lip was observed and the upper and lower lips were 5.0 mm ahead and 2.0 mm behind from the esthetic line (E-line), respectively (Figure 3A, Table 1). The mandibular growth spurt had passed according to the hand-wrist radiograph.

The jaw movement during gum chewing and EMG activity of the masseter and anterior temporalis muscles during clenching were examined by a 6 degrees-of-freedom jaw movement and EMG recording system (Gnathohexagraph system, version 1.31, Ono Sokki, Kanagawa, Japan).[30,35] The jaw movements of 20 cycles during chewing and masticatory muscle activity for 20 seconds during clenching were analyzed, respectively. If the jaw-movement trajectory in the opening phase was medial of that of the closing phase on the frontal view, the jaw-movement pattern was classified into the normal type.

Occlusal force and the occlusal contact area were also examined by an occlusal force recording system (Dental Prescale & Occluzer, Fuji Film, Tokyo, Japan).[29,36] Around 90% of jaw movement during gum chewing was the normal type in the frontal view (Table 2). The maximum gap without pain was 44.2 mm. The EMG activity of the masseter and anterior temporalis muscles was low, maximum occlusal force was weak, and the occlusal contact area was narrow when compared with normal subjects[26,37] (Figure 4, Table 2).

Diagnosis

This case was diagnosed as an Angle Class II division 1 malocclusion with low mandibular plane angle, skeletal Class II, mandibular retrusion, and scissors bite in the premolar region.

Treatment Plan

Treatment was planned as follows:

—Lengthening of the mandibular body by distraction osteogenesis to improve the mandibular retrusion;

—Expansion of the lower constricted dental arch to improve the scissors bite in the premolar region with lower constricted dental arch; and

—Retraction of the maxillary anterior teeth and aligning all teeth with preadjusted edgewise appliances to reduce the overjet and overbite.

Treatment Alternatives

In the patient with skeletal Class II malocclusion and mandibular retrusion after the growth spurt, the alternative treatment method is camouflage orthodontic treatment with extraction. However, this treatment does not resolve the skeletal problem. Therefore, we selected surgical orthodontic treatment because his chief complaint was chin deficiency and a protruding upper lip. Two surgical techniques are available, bilateral sagittal split osteotomy or mandibular distraction osteogenesis. We selected mandibular distraction osteogenesis since the amount of mandibular distraction needed was more than 7 mm.

Treatment Progress

The lower arch in the premolar region was expanded with a quad helix appliance for 5 months (at age 15 years 4 months) to correct the scissors bite. A preadjusted edgewise appliance (0.018 × 0.025 inch) was placed in the maxillary and mandibular arches 3 days before mandibular distraction osteogenesis. A mandibular distraction osteogenesis was performed using an intraoral distraction devise (KLS Martin, Umkirch, Germany) that was attached to the lower third molar area and the anterior border of the mandibular rami (at age 15 years 11 months). The device was activated on day 8 after surgery at a rate of 1 mm/day (0.5 mm every 12 hours). Activation was continued for 9 days so that the patient had an edge-to-edge occlusion. At the end of the distraction period a lateral open bite was observed. Postsurgical orthodontic treatment such as leveling and alignment of the teeth was then performed (Figure 3B). Up and down elastics were used in the premolars area for 8 months during and after the distraction to prevent postoperative skeletal relapse and to improve the lateral open bite. Eight months after surgery, the distraction device was removed. After 14 months of edgewise treatment, a skeletal Class I apical base relationship, good facial profile, and optimum intercuspation of the teeth were achieved. The patient wore Begg-type and Hawley-type retainers all day for 1 year.

RESULTS Return to TOC

At the end of treatment, the patient showed a good facial profile, a balanced lip line, and an acceptable occlusion. The chin deficiency, protruding lip, deep mentolabial sulcus, and protrusive upper lip were improved (Figure 1c,d). The scissors bite in the premolar region was also improved. The dental arches were aligned and leveled with an ideal overjet and overbite (Figure 2g–l). The lateral cephalometric analysis indicated a skeletal Class I apical base relationship with an ANB angle of 4.0° and balanced face with an average mandibular plane angle of 25.0° and a gonial angle of 125°. The mandible was advanced horizontally 3 mm and vertically 12 mm. The upper incisors were retruded with U1-FH angle of 108°. According to the soft tissue analysis, the lower facial height was in the normal range with a subnasale-Gn of 70.5 mm. A protruding upper lip and retracted lower lip were improved such that the upper and lower lips were 2.0 mm and 1.5 mm ahead of the E-line, respectively (Figures 3C and 5, Table 1).

The jaw-movement pattern did not change on the frontal view during gum chewing. However, the maximum gap without pain improved from 44.2 mm to 51.2 mm. The masseter and anterior temporalis muscle activity, occlusal force, and occlusal contact area increased after treatment (Figure 4, Table 2).

DISCUSSION Return to TOC

We performed an orthodontic treatment combined with mandibular distraction osteogenesis in a 15-year-old patient who wanted correction of his chin deficiency and a protruding upper lip. In the current case, the mandibular body length increased by 2.5 mm. The skeletal problem was improved and a good facial profile was achieved. The patient showed acceptable good occlusion and maximum interdigitation of the teeth due to the increase of the occlusal area after the treatment. The maximum gap without pain, masticatory muscle activity, and occlusal force increased after orthodontic treatment combined with mandibular distraction osteogenesis. The increase in the maximum gap after treatment may be due to lengthening of the mandibular body by distraction osteogenesis.

In this case, the EMG activity of the masseter and anterior temporalis muscles and occlusal force at pretreatment were very low because the occlusal contact area was narrow. With regard to the increases in muscle activity and occlusal force, previous reports suggested close relationships between the masticatory muscle activity, occlusal force, and occlusal contact area.[38,39] Therefore, the increase in occlusal contact area after treatment may have contributed to the increase in muscle activity and occlusal force.

There have been many reports that the stomatognathic function changed after mandibular advancement surgery by bilateral sagittal split osteotomy.[23–26,40,41] Some cases with skeletal Class II showed an increase in maximum occlusal force or the masseter and anterior temporalis muscle activity after orthognathic surgery.[23,25,40] However, few cases with skeletal Class II had improved stomatognathic function after orthognathic surgery. Other cases showed unchanged or worsened function, eg, the masseter and anterior temporalis muscle activity or maximum occlusal force did not change[25,26] or the occlusal force decreased[23,41] after orthognathic surgery. However, to date, there have been few reports in which the changes of stomatognathic function were examined after mandibular distraction osteogenesis in patients with skeletal Class II.

The present case showed improvement of stomatognathic function and no signs or symptoms of TMD after orthodontic treatment combined with mandibular distraction osteogenesis. Therefore, it was suggested that surgical orthodontic treatment with mandibular distraction osteogenesis was effective in resolving the skeletal disharmonies, and improving the facial profile, occlusion, and stomatognathic function.

CONCLUSION Return to TOC

- Surgical orthodontic treatment combined with mandibular distraction osteogenesis may be an effective method for improving occlusion, facial profile, and stomatognathic function.

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TABLES Return to TOC

Table 1. Cephalometric Measurements

Measurements	Pretreatment	Posttreatment	Normative Value Mean ± SD
SNA, degrees	85.5	85.0	81.8 ± 3.1[31]
SNB, degrees	78.5	81.0	78.6 ± 3.1[31]
ANB, degrees	7.0	4.0	3.3 ± 2.7[31]
MP angle, degrees	12.0	25.0	26.3 ± 6.3[31]
IMPA, degrees	102.5	93.0	94.7 ± 7.2[31]
Gonial angle, degrees	107.5	125.0	125.6 ± 5.1[31]
Ar-Go, mm	50.0	47.0	48.6 ± 3.8[31]
Go-Me, mm	78.0	80.5	73.1 ± 3.8[31]
U1 to FH, degrees	124.5	108.0	112.9 ± 7.8[31]
U1 to APo, mm	10.5	5.0	7.1 ± 2.3[31]
L1 to FH, degrees	65.5	62.0	59.0 ± 6.7[31]
L1 to APo, mm	−3.5	2.5	3.9 ± 2.3[31]
Subnasale-Gn, mm	59.5	70.5	72.0 ± 6.0[32]
G-Sn/Sn-Me, mm/mm	1.2	1.0	1.1 ± 0.1[33]
Upper lip to E-line, mm	5.0	2.0	−0.3[34]
Lower lip to E-line, mm	−2.0	1.5	2.0[34]

Table 2. Variables in the Stomatognathic Function

Variables	Pretreatment	Posttreatment	Normative Value Range/Mean ± SD
Normal type ratio of jaw-movement pattern, %			
On the right side	90.0	95.0	60–100
On the left side	100.0	90.0	63–100
Maximum gape, mm	44.2	51.2	47.6 ± 5.7
Occlusal force during maximum clenching, N	260.9	378.8	850.0 ± 231.9
Occlusal contact area, mm²	6.2	11.0	19.6 ± 6.6

FIGURES Return to TOC

Click on thumbnail for full-sized image.

Figure 1. Facial photographs. (a and b) Pretreatment, age 15 years 0 months. (c and d) Posttreatment, age 17 years 1 month

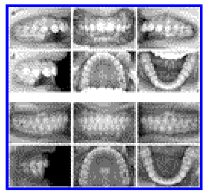

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Figure 2. Pretreatment intraoral photographs. (a–f) Pretreatment, age 15 years 0 months. (g–l) Posttreatment, age 17 years 1 month

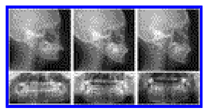

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Figure 3. Lateral cephalographs and panoramic radiographs. (A) Pretreatment, age 15 years 0 months. (B) 1 month after mandibular distraction osteogenesis, age 16 years 0 months. (C) Posttreatment, age 17 years 1 month

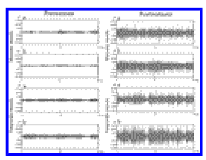

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Figure 4. Masseter and temporalis muscle activity during clenching. (a) Right side. (b) Left side

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Figure 5. Superimposition of cephalometric tracings before (solid line) and after (dotted line) treatment. (A) A best-fit on the anterior wall of sella turcica, the greater wings of the sphenoid, the cribriform plate, the orbital roofs, and the surface of frontal bone. (B) A best-fit on the mandibular plane at Me

[a] Assistant Professor, Field of Developmental Medicine, Health Research Course, Department of Orthodontics, Graduate School of Medical and Dental Sciences, Kagoshima University, Kagoshima, Japan

[b] Assistant Professor, Department of Oral and Maxillofacial Surgery, Miyazaki Medical College, University of Miyazaki, Miyazaki, Japan

[c] Director, Department of Orthodontics, Maxillofacial Unit, Oita Oka Hospital, Oita, Japan

[d] Professor and Department Chair, Maxillofacial Diagnostic and Surgical Sciences, Graduate School of Medical and Dental Sciences, Kagoshima University, Kagoshima, Japan

[e] Professor and Department Chair, Field of Developmental Medicine, Health Research Course, Department of Orthodontics, Graduate School of Medical and Dental Sciences, Kagoshima University, Kagoshima, Japan

Corresponding author: Dr Shouichi Miyawaki, Field of Developmental Medicine, Health Research Course, Graduate School of Medical and Dental Sciences, Department of Orthodontics, 8-35-1 Sakuragaoka, Kagoshima, Kagoshima 890-8544, Japan (E-mail: miyawaki@denta.hal.kagoshima-u.ac.jp)