Surgical Orthodontic Treatment in Case of Severe High Angle Skeletal Class II Malocclusion and Mandibular Retrusion

Chie Tachiki¹⁾, Masae Yamamoto²⁾, Takashi Takaki³⁾ and Yasushi Nishii¹⁾

¹⁾ *Department of Orthodontics, Tokyo Dental College,
2-9-18 Kanda-Misakicho, Chiyoda-ku, Tokyo 101-0061, Japan*

²⁾ *Department of Oral Pathobiological Science and Surgery, Tokyo Dental College,
5-11-13 Sugano, Ichikawa-shi, Chiba 272-8513, Japan*

³⁾ *Department of Oral and Maxillofacial Surgery, Tokyo Dental College,
1-2-2 Masago, Mihama-ku, Chiba 261-8502, Japan*

Received 9 April, 2020/Accepted for Publication 11 May, 2020

Published Online in J-STAGE 10 November, 2020

Abstract

This report describes a patient with severe high angle class II malocclusion and mandibular retrusion in whom surgical orthodontic treatment to prevent an increase in ramus height resulted in a significant improvement in esthetics and long-term stability. The patient was a woman aged 30 years 5 months who presented with the chief complaint of maxillary protrusion. She had a convex facial type, a chin button on lip sealing, and a gummy smile. Cephalometric analysis revealed a normal maxilla anterior-posterior position, but significant mandibular retrusion with pronounced clockwise rotation. The anterior maxillary tooth axis was standard, but labially inclined in the mandible. Based on these findings, the diagnosis was skeletal class II high angle malocclusion and mandibular retrusion. The proposed treatment plan comprised 2-jaw surgery with premolar extraction. Le Fort I osteotomy, in particular, was planned in the maxilla to move the ANS upward by 3.0 mm and the PNS downward by 3.0 mm. Sagittal split ramus osteotomy (SSRO) was planned to adjust the mandible and move the mandible forward by 10.0 mm. To prevent postoperative relapse, the short lingual split method was used in performing the SSRO. The mandible was split to minimize stretching of the median pterygoid muscle. Postoperatively, the ANS, PNS, and pogonion showed movement of 2.0 mm upward, 3.0 mm downward, and 8.0 mm forward, respectively. Additionally, lip closure was now natural, and the gummy smile had markedly improved. At 6 years postoperatively, there has been no change skeletally or dentally. Follow-up is being continued to monitor further progress.

Key words: Skeletal class II — High angle case —
Surgical orthodontic treatment — Counter-clockwise rotation —
Stability

Introduction

Many studies have reported a tendency toward relapse in patients with skeletal class II malocclusion and mandibular retrusion who have undergone mandibular advancement procedures^{2,5,7,9,10,12}. Minimizing mandibular advancement and adaptation of soft tissue of the mandible is considered essential in preventing such relapse and obtaining long-term stability⁴. This indicates that mandibular advancement will need to be compromised to obtain stability. Maxillomandibular downward movement by means of orthognathic surgery is a significant risk factor for post-surgical orthodontic relapse, especially in high angle cases where there is a large mandibular plane angle and lower facial height. This type of case is extremely challenging because of the inverse relationship between achieving esthetic improvement and long-term stability⁴.

The data suggest that patients with a skeletal maxillary protrusion and mandibular retrusion are at higher risk of orthodontic relapse, and extensive surgical orthodontic treatment is necessary to prevent this¹⁵. This report presents a case where surgical orthodontic treatment with short lingual sagittal split ramus osteotomy (SSRO) in a patient with severe high angle class II malocclusion and mandibular retrusion resulted in both significant esthetic improvement and long-term stability.

Case Presentation

Informed consent for inclusion in this case report was obtained prior to initiating treatment. The patient was a woman aged 30 years 5 months who presented with the chief complaint of maxillary protrusion, something she claimed had developed commencing in elementary school, and a condition that she shared with her mother. Her medical history also revealed epilepsy commencing at the age of 3 years.

The frontal facial view revealed a rightward

shift in the mandible. A chin button appeared on sealing of the lips. Moreover, due to significant gingival exposure of the maxillary anterior teeth, the patient exhibited a gummy smile. The lateral view revealed mandibular retrusion, indicating a convex facial type (Fig. 1). Intraoral findings revealed that the right maxillary second premolar had been extracted due to dental caries. The molars were in a Class-II relationship on the right side and Class-I relationship on the left side; overbite was 2.0 mm, and overjet was 9.0 mm and 6.0 mm on the right and left, respectively. The arch length discrepancy was +5.0 mm and -2.0 mm in the maxilla and mandible, respectively (Fig. 2). Both dental arches were narrowed, and the arch forms of the maxilla and mandible were taper-type and ovoid-type, respectively. The patient had many cavities and displayed characteristics consistent with chronic periodontitis (Fig. 3).

Cephalometric analysis revealed normal positioning of the maxilla, so maxillary protrusion was due to a retruded mandible. The anteroposterior patterns showed an SNA, SNB, and ANB of 79.0°, 70.5°, and 8.5°, respectively. The mandibular plane angle, Y-axis, and gonial angles were 49.0°, 71.0°, and 135.0°, respectively, indicating a severe high-angle case. The maxillary anterior teeth displayed normal inclination, with a U1-to-FH value of 114.0°. The mandibular anterior teeth showed FMIA and IMPA values of 38.0° and 93.0°, indicating a strong labial inclination. Soft tissue findings showed 7.5 mm protrusion of the upper lip and 11.0 mm protrusion of the lower lip from the E-line (Fig. 4, Table 1). A functional problem that was observed was jaw clicking during mouth opening at the right temporomandibular joint. No significant deformity was found, however.

Based on these findings, the diagnosis was a skeletal class-II severe high angle and mandibular retrusion. The problems this case presented were as follows: 1) severe high angle class-II malocclusion and mandibular retrusion; 2) a pronounced gummy smile; 3) leftward inclination of the occlusal plane; 4)

Fig. 1 Facial photographs at pretreatment

Fig. 2 Intraoral photographs at pretreatment

Fig. 3 Panoramic radiograph at pretreatment

protrusion of the upper and lower lips, making lip sealing difficult; and 5) chronic periodontitis and caries.

Clinical Procedures and Outcomes

Surgical orthodontic intervention was rec-

ommended to treat the mandibular retraction, gummy smile, and inclination of the occlusal plane. Treatment was performed in the order of preoperative orthodontic treatment, orthognathic surgery, and postoperative orthodontic treatment. These procedures were performed in accordance with the standard protocol for surgical orthodontic treatment.

The plan was to shift the maxilla 3.0 mm upward in the anterior region (ANS) and 3.0 mm downward in the posterior region (PNS) by means of Le Fort I osteotomy. The left side of the occlusal plane was to be adjusted 2.0 mm upward to balance the plane. Since movement of the maxilla causes counter-clockwise rotation of the occlusal plane, short lingual SSRO was planned to realign the mandible with the maxilla and move the pogonion forward by 10.0 mm. The left maxillary first premolar and bilateral mandibular

Table 1 Cephalometric measurements at pretreatment, post-treatment, and at 6 years 1 month retention.

Cephalometric measurements	Mean $\pm$ S.D.	Pre-treatment	Post-treatment	6.1 years retention
SNA (deg.)	83.2 $\pm$ 3.44	79.0	79.5	79.0
SNB (deg.)	80.4 $\pm$ 3.22	70.5	74.5	74.5
ANB (deg.)	2.8 $\pm$ 1.80	8.5	5.0	4.5
Facial angle (deg.)	85.9 $\pm$ 1.69	77.0	79.0	82.0
Y-axis (deg.)	64.3 $\pm$ 2.27	71.0	74.0	71.0
Mandibular plane angle (deg.)	26.4 $\pm$ 3.83	49.0	47.5	41.0
Gonial angle (deg.)	120.2 $\pm$ 4.04	135.0	135.0	130.0
Occlusal plane angle (deg.)	8.6 $\pm$ 5.56	22.0	13.0	12.5
Interincisal angle (deg.)	121.9 $\pm$ 3.69	104.0	140.0	138.5
U1 to FH (deg.)	115.2 $\pm$ 5.86	114.0	97.0	97.0
U1 to A-Pog (mm)	9.2 $\pm$ 2.24	19.0	6.5	6.0
L1 to FH (FMIA) (deg.)	58.0 $\pm$ 5.98	38.0	56.0	56.0
L1 to MP (IMPA) (deg.)	98.2 $\pm$ 4.08	93.0	76.5	83.0
L1 to A-Pog (mm)	3.0 $\pm$ 1.0	11.0	4.0	3.0
Lower lip to E-line (mm)	2.0 $\pm$ 1.5	11.0	3.0	-0.5

Fig. 4 Cephalometric tracing and main measurement planes at pretreatment

first premolars were planned to be extracted to resolve crowding and improve inclination of the anterior teeth. The maxillary anterior teeth were planned to be shifted more than

7.0 mm lingually to ensure proper postoperative alignment. Similarly, the mandibular anterior teeth were planned to be shifted 4.0 mm lingually, assuming that the standard FMIA would have been achieved following surgical intervention. Since anchorage of the maxillary molars would be affected by the 2.0 mm of mesial movement, a quad-helix was planned to be placed for anchorage and arch expansion. Prior to initiating presurgical orthodontic treatment, general periodontal treatment was planned to treat the chronic periodontitis and caries. As presurgical orthodontic treatment, a pre-adjusted edgewise appliance was used with 0.022-inch slots. After placing the quad-helix, multibracket appliances with 0.014-inch NiTi wires were placed on the upper and lower teeth, followed by extraction of the premolars. During levelling, the NiTi wire size was increased to 0.017 $\times$ 0.025 inches. A 0.017 $\times$ 0.025-inch stainless steel wire was used to retract the canines. At 11 months after commencement of presurgical orthodontic treatment, anterior retraction was performed using a 0.019 $\times$ 0.025-inch stainless steel wire. At 20 months, anterior retraction was completed (Figs. 5, 6). At 22

Fig. 5 Facial photographs after presurgical treatment

Fig. 6 Intraoral photographs after presurgical treatment

months, 2-jaw surgery was performed.

One important goal of adopting this method of treatment was to maintain the height of the ramus while achieving mandibular advancement and maxillary impaction by means of short lingual osteotomy. Postsurgical orthodontic treatment was performed over a period of 7 months. Maintenance was commenced after removal of the brackets (Figs. 7–10). The duration of active orthodontic treatment was 2 years 6 months.

Following treatment, an improvement was observed in both mandibular retrusion and lip protrusion. Although the anterior portion of the maxilla showed an upward shift, significantly decreasing gingival exposure of the anterior teeth, a slight gummy smile remained. A significant esthetic improvement was observed on lip closure.

Superimposition of lateral cephalogram images obtained at before and after treatment

displayed a shift of 2.0 mm upward at the ANS and 3.0 mm downward at the PNS in the maxilla. Using SSRO, the mandible was adjusted in accordance with the maxilla, and the pogonion was adjusted 8.0 mm forward. As a result, the ANB improved from 8.5° to 5.0°. Slight mandibular retrusion remained, however. The E-line showed a significant improvement, with protrusion of the upper lip decreasing from +7.5 mm to +1.0 mm, and that of the lower lip decreasing from +11.0 mm to +3.0 mm. The maxillary anterior teeth shifted 8.0 mm lingually, and the U1 to FH value was relatively small. The mandibular anterior teeth shifted 5.0 mm lingually, resulting in a normal tooth axis, with a FMIA value of 56.0°. The maxillary molars showed 2.5 mm mesial movement (Fig. 11).

The dental arch was enlarged, becoming ovoid as the maxillary canine diameter increased by 2.5 mm. The right maxillary lat-

Fig. 7 Facial photographs at post-treatment

Fig. 8 Intraoral photographs at post-treatment

Fig. 9 Panoramic radiograph at post-treatment

eral incisor was identified as a peg tooth. Therefore, class II molar occlusion was observed on the right side. The left maxillary second premolar was also identified as a peg tooth. Therefore, additional space was created for placement of a prosthetic crown.

A fixed-type retainer was placed on the maxillomandibular anterior teeth. A circum-

Fig. 10 Cephalometric tracing and main measurement planes at post-treatment

Fig. 11 Superimposition of cephalometric tracing pre- and post-treatment

(a) Superimposition at S-N plane at Sella, (b) Superimposition at palatal plane, (c) Superimposition at mandibular symphysis
Solid line: pretreatment. Dashed line: post-treatment.

Fig. 12 Facial photographs at 6 years 1 month retention

ferential type retainer was worn every day for a year. Overall, the patient complied with the required hours of retainer wear and regular maintenance visits.

Genioplasty was then performed during plate removal surgery at 1 year after the initial surgical procedure to obtain functional stability and smooth lip closure, which was requested by the patient. The profile view revealed pronounced lower facial height, so genioplasty was performed to shorten the mental region by 3.0 mm and move the chin forward by 4.5 mm. This procedure resulted in a significant esthetic improvement, with the upper and lower lips shifting 1.0 mm and -0.5 mm from the E-line, respectively.

No noticeable change has been observed in the skeletal or tooth axis at approximately 6 years 1 month of retention (Figs. 12–16). Some spaces have emerged in the dentition, however, especially in the left maxillary second premolar region, where prosthetic treatment was incomplete due to poor retainer wear. The patient has been instructed to continue wearing retainers for space control.

Discussion

1. Orthognathic surgical method

Mandibular advancement is limited in the surgical orthodontic treatment of high angle

Fig. 13 Intraoral photographs at 6 years 1 month retention

Fig. 14 Panoramic radiograph at 6 years 1 month retention

Fig. 15 Cephalometric tracing on main measurement planes at 6 years 1 month retention

class II cases due to a high correlation between increased mandibular advancement and post-surgical relapse. Therefore, high angle cases where increased mandibular advancement is required are considered extremely difficult, as it is challenging to simultaneously achieve esthetic improvement and ensure long-term stability. Wolford *et al.* reported that instead of performing mandibular advancement in isolation, it should be conducted in conjunction with maxillary (two-jaw) surgery to solve that issue. With this procedure, the maxilla is rotated upwards in the anterior region and downwards in the posterior region. The decrease in the occlusal plane angle followed by counter-clockwise rotation of the mandible allows for an increase in mandibular advancement. However, this maxillomandibular movement usually leads to an increase in posterior facial height¹⁵⁾. An increase in posterior facial height and subsequent increase in

vertical ramus height causes the medial pterygoid muscles to stretch, directly contributing to postoperative relapse^{3,11)}. Therefore, it is important to implement a surgical method that does not increase the height of the ramus. Studies have shown that mandibular advancement and maxillary impacted surgery enable the height of the ramus to be maintained while stabilizing maxillomandibular bone^{11,14)}.

The data referenced thus far has been reported primarily in Caucasian patients. It is important to take differences in craniofacial structures depending on anthropomorphic

Fig. 16 Superimposition of cephalometric tracing post-treatment and at 6 years 1 month retention

(a) Superimposition of S-N plane at Sella, (b) Superimposition of palatal plane, (c) Superimposition at mandibular symphysis, Solid line: post-treatment. Dashed line: 6 years 1 month retention.

type into account, therefore, as such differences will impact treatment. For example, Japanese patients tend to exhibit higher mandibular retrusion and labial inclination of the anterior teeth, steeper mandibular planes, and a greater tendency toward high angle facial types⁶⁾. High angle facial types possess a shorter ramus height, which is more difficult to maintain during mandibular advancement, primarily because this height will most likely increase⁸⁾. In contrast to low angle facial type cases, high angle facial types require a significant increase in ramus height. However, increasing mandibular advancement decreases postsurgical stability. Therefore, to prevent orthodontic relapse in high angle facial type cases, mandibular advancement is limited, which restricts esthetic improvement.

The diagnosis in the present patient was a high-angle facial type with severe mandibular retrusion and labial inclination of the mandibular anterior teeth. During the SSRO procedure, a short lingual split was performed on the mandible. The inner body of the mandible was cut as far forward as possible so that the distal bone fragment was not attached to the median pterygoid muscle (Fig. 17). The purpose of this was to reduce the stretch of

Fig. 17 Schematic of orthognathic surgery.

Arrow indicates direction of movement. Inner mandible was cut as far forward as possible to avoid medial pterygoid muscle. Mandible was rotated forward in counter-clockwise direction.

the median pterygoid muscle and subsequently decrease the possibility of postsurgical relapse. Adopting this modified surgical procedure allowed a greater degree of mandibular advancement, which resulted in significant esthetic improvement.

2. Treatment planning

Taking postsurgical facial issues into consideration preoperatively, the tooth axis and position of the maxillary and mandibular anterior teeth had to be determined for pre-surgical orthodontic treatment. Wolford *et al.* reported that a reduction in the occlusal plane angle, mandibular plane angle, and mandibular incisor angulation, and an increase in the maxillary incisor angulation were observed following counter-clockwise rotation of the maxillomandibular complex¹⁵⁾. Therefore, in the present patient, the maxillary incisors were intentionally angulated lingually during presurgical orthodontic treatment to conform with the planned counter-clockwise rotation of the maxilla. By doing this, the U1-to-FH value was expected to be normal after surgery. For vertical repositioning of the maxilla, more than 5 mm impaction was required for the ANS due to the presence of a pronounced gummy smile. This was because the edge of the maxillary incisors is ideally 3–5 mm below the level of a relaxed upper lip^{1,13)}. The nose was tilted upward in the present patient, so ANS impaction was limited to 3.0 mm to prevent this worsening. Counter-clockwise rotation of the occlusal plane angle was anticipated to change from 22.0° to 10.0°, and the plan was to shift the PNS downward by 3.0 mm. Similarly, the mandibular anterior teeth were shifted lingually based on the prediction of a postsurgical decrease in the mandibular plane angle. As a result, a large forward movement of 10.0 mm in the pogonion was planned for the mandible.

3. Treatment results

As a result of treatment, occlusion and profile showed a dramatic improvement. The patient reported satisfaction with all the esthetic, psychological, and masticatory aspects of the treatment she had received. A slight gummy smile persisted, however, because the anterior region of the maxilla did not rotate as much as expected. There was also a slight lack of mandibular advancement, which resulted in large overjet postsurgically.

The maxillary anterior teeth were lingually inclined during postsurgical orthodontic treatment to improve the overjet. Genioplasty was performed during plate removal surgery to address functional problems at the patient's request. Further esthetic improvements were made during this procedure by reducing the lower facial height and moving the mental region forward. After 6 years 1 month retention, anteroposterior and vertical cephalometric traces were superimposed and analyzed. No skeletal changes were observed, suggesting that no relapse has occurred. Theoretically, short lingual SSRO reduces stretch in the median pterygoid muscle, thus decreasing the possibility of postsurgical relapse. To our knowledge, however, no case studies to date have reported outcomes with this method. The present case demonstrated that careful planning and modifying orthognathic surgery methods such as short lingual SSRO, followed by proper execution, can lead to esthetic improvement and long-term stability, even in severe high angle facial type class II cases.

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Correspondence: Dr.

Chie Tachiki
Department of Orthodontics,
Tokyo Dental College
2-9-18 Kanda-Misakicho, Chiyoda-ku,
Tokyo 101-0061, Japan
E-mail: tachikichie@tdc.ac.jp