Surgical-orthodontic Treatment of a Patient with Severe Skeletal Class III Anterior Open Bite and High Mandibular Plane by Preserving the Posterior Facial Height

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SURGICAL-ORTHODONTIC TREATMENT OF A PATIENT WITH SEVERE SKELETAL CLASS III ANTERIOR OPEN BITE AND HIGH MANDIBULAR PLANE BY PRESERVING THE POSTERIOR FACIAL HEIGHT

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Class III malocclusions with a hyperdivergent vertical facial pattern are often difficult to treat without combining the surgical-orthodontic approach. The aim of this article is to present a collaborative management of a case with severe skeletal class III and anterior open bite. The 19-year-old man was characterized with midface deficiency, mandibular prognathism, high mandibular plane angle, long lower facial height, and excessive anterior open bite. The achievement of a stable surgical setup in interdigitation prior to orthognathic surgery (OGS) is critical for a successful treatment via dental decompensation. Two-jaw surgery with clockwise rotation of the maxilla and bilateral sagittal split osteotomies was performed to correct the skeletal Class III malocclusion and anterior open bite. An acceptable smile arc and facial profile were achieved. The total treatment duration was 28 months. The treatment outcome presented a good facial profile and solid occlusion. Moreover, the skeletal and dental relationships were stable 2 years after finish. Accurate diagnosis and treatment design, good patient’s compliance, and effective communication are essential to correct the severe dentoskeletal deformities.


Keywords: Class III malocclusion; anterior open bite; vertical facial pattern
INTRODUCTION

Class III malocclusions represent a small fraction of the malocclusions in orthodontic patients, with an incidence of 1–4% in Caucasians. However, in the Asian population the incidence ranges from 9%–19% owing to the large percentage of Asian patients with maxillary deficiency. The incidence of Class III malocclusion is reported to be 4–13% in Japanese and 4–14% in Chinese patients. In Lin’s study, in Chinese children with age in 9 to 15 years, the prevalence of pseudo- and true Class III malocclusion was 2.3% and 1.7%, respectively.

Patients with skeletal Class III malocclusion can be treated using orthopedics, orthodontic camouflage, or orthodontic treatment combined with orthognathic surgery (OGS). The optimal method depends on the age of the patient, the stage of craniofacial development, the degree of skeletal discrepancy, the skeletal pattern, and the facial profile. Anterior open bite combined with any malocclusion makes both features difficult to correct, particularly in concurrent with a Class III malocclusion.

Camouflage orthodontic treatment can result in proper occlusion and esthetics in nonsurgical cases of Class III malocclusion. However, in surgical cases of Class III malocclusion, dental decompensation is necessary before surgery to facilitate skeletal corrections. Several studies have reported that the most effective treatment option in adult patients with skeletal open bite is surgical repositioning of either the maxilla or both jaws. In addition, Sugawara et al. found that in patients with skeletal Class III open bite, moving the anterior maxillary structures down with clockwise rotation of the palatal plane effectively produces a reasonably stable correction of the anterior open bite.

Herein, we present the treatment of an adult patient with severe skeletal Class III maxillary deficiency combined with mandibular prognathism, an extremely high mandibular plane angle, and anterior open bite. With the aid of the reduction genioplasty, LeFort I osteotomy, and bilateral sagittal split osteotomy (BSSO), the clockwise rotation of the maxillomandibular complex (MMC) altered the existing occlusal plane, the outcome demonstrated a consonant smile curve, harmonized facial aesthetics, a stable skeletal relationship and good dental occlusion.

CASE REPORT

A 19-year-old male patient who had no history of illness or trauma, presented the following complaints including inability to bite off food with his incisors, difficulty chewing, tooth crowding over both arches, a long face, and occasional involuntary opening of the mouth.

The extraoral examination revealed that the patient had skeletal Class III malocclusion with midface deficiency, mandibular prognathism, a high mandibular plane, an excessively long lower third of the face, facial asymmetry, an acute nasolabial angle, a flat labiomental fold due to straining to compensate for the vertical discrepancy, lip incompetence with mentalis strain, a flat smile arc, and uncoordinated dental and facial midlines (Figures 1). The intraoral examination revealed that the patient had Angle’s Class III malocclusion with anterior open bite and negative overjet, bilateral posterior and anterior crossbite, non-coincident upper and lower dental midlines, and large interincisal angle which due to flaring maxillary incisors and retroclined lower incisors, a reverse curve of Spee in the lower arch, crowding of both arches, mesial tipping of the lower arch, and impaction of tooth #18 (Figures 1-3 and Table 1).
Figure 1. Facial and intraoral photographs, before treatment.

Figure 2. Study models in before treatment.
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Figure 3. A Lateral cephalometric film. B Panoramic radiographs before treatment.

Table 1. Cephalometric summary.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
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</thead>
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<tr>
<td></td>
<td>Skeletal</td>
<td></td>
</tr>
<tr>
<td>SNA°</td>
<td>79.8</td>
<td>84.3</td>
</tr>
<tr>
<td>SNB°</td>
<td>84.9</td>
<td>80.5</td>
</tr>
<tr>
<td>ANB°</td>
<td>-5.1</td>
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<tr>
<td>AO-BO (mm)</td>
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<tr>
<td>SN-MP°</td>
<td>44.3</td>
<td>42.1</td>
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<tr>
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<td>35.2</td>
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<tr>
<td>Y-axis°</td>
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<td>68.6</td>
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<tr>
<td>Lower Go angle°</td>
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<td>Articular angle°</td>
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<td>PFH (mm)</td>
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<td>9.6</td>
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<tr>
<td>AFH (mm)</td>
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<td>14.8</td>
</tr>
<tr>
<td>PFH/AFH (%)</td>
<td>61.5</td>
<td>63.6</td>
</tr>
<tr>
<td></td>
<td>Dental</td>
<td></td>
</tr>
<tr>
<td>1 TO NA (mm)</td>
<td>1.1</td>
<td>1.2</td>
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<td>1 TO SN°</td>
<td>109</td>
<td>102.9</td>
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<tr>
<td>1 TO NB (mm)</td>
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<tr>
<td>1 TO MP°</td>
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<td>FMIA°</td>
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<tr>
<td>OCC. PLANE angle°</td>
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<tr>
<td></td>
<td>Facial</td>
<td></td>
</tr>
<tr>
<td>E-LINE (mm)</td>
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<tr>
<td></td>
<td>Lower</td>
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<td>NLA°</td>
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<td>Z-Angle°</td>
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<tr>
<td>UPPER LIP (mm)</td>
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<td>15</td>
</tr>
<tr>
<td>TOTAL CHIN (mm)</td>
<td>8</td>
<td>16</td>
</tr>
</tbody>
</table>
TREATMENT OBJECTIVES

- To correct the midface deficiency, the vertical maxillary excess and anterior open bite; to correct the mandibular prognathism and the excessive lower third of the face; and to correct the canting occlusal plane in facial skeleton.
- To improve the acute nasolabial angle and paranasal depression, to improve the flat labiomental fold and chin contour, and to shape the bilateral gonial angle in facial soft tissue.
- To correct the dental compensation and anterior open bite.
- To achieve a stable, functional occlusion by establish Class I canine relationships as well as a consonant smile arc and competent lip posture.

TREATMENT ALTERNATIVES

The first treatment option included advanced LeFort I osteotomy, BSSO mandibular setback, clockwise rotation of the MMC, and vertical reduction genioplasty with advancement. This option could improve the paranasal depression and mandibular prognathism and result in a balanced facial profile.

The second treatment option was one-jaw surgery mandibular surgery. The intrusion of posterior teeth and correction of occlusal plane cant would be corrected with the application of temporary anchorage devices (TADs) over the posterior maxilla. This method could only correct the anterior open bite, but compromised facial esthetics was expected.

The patient chose the two-jaw surgery to achieve a better facial aesthetics.

TREATMENT PLAN

A comprehensive diagnosis, treatment objectives, and treatment alternative were presented to the patient. With patient’s consent, the following treatment plan was chosen:

- Placement of pre-adjusted edgewise appliances to level, align and coordinate the dental arches and to correct dental compensation.
- OGS: 1) LeFort I osteotomy with advancement, posterior maxillary impaction and clockwise rotation of occlusal plane to correct canting occlusal plane and improve the paranasal depression; 2) BSSO to correct skeletal discrepancy, anterior open bite, and mandibular prognathism.
- Vertical reduction genioplasty with advancement to improve the flat labiomental fold and chin contour.
- Surgical-orthodontic combined treatment to get balanced facial profile and good interdigitation.

TREATMENT PROGRESS

Preoperative orthodontic treatment was carried out by using the pre-adjusted 0.022-inch edgewise appliances. Before orthodontic treatment, the maxillary right third molar was extracted. Leveling, alignment, and arch coordination were then performed to achieve dental decompensation. Preoperative orthodontic treatment lasted for 12 months and was completed using 0.017 × 0.022 inch stainless steel (SS) arch wires (Figure 4).

The orthognathic surgery consisted of two-jaw surgery including LeFort I osteotomy, BSSO and genioplasty. The surgical procedure on the maxilla involved a one-piece LeFort I osteotomy with maxillary advancement of about 3 mm on the right side and 5 mm on the left side to correct the paranasal depression. The posterior maxilla was impacted about 5 mm on the right side and 3 mm on the left side to alter the occlusal plane and correct the anterior open bite. BSSO was performed on the mandible with backward of 9 mm on the right side and 12 mm on the left side to establish the correct skeletal and dental relationships. Genioplasty was performed with chin advancement 3 mm and reduction 3 mm to correct the excessive lower facial height and improve the chin contour.
Postoperative orthodontic treatment started 6 weeks after surgery (Figure 5 and Figure 6). The orthodontic treatment kept progressing with detailing and finishing, achieving Class I canine relationship, normal overbite and overjet, and coincident facial and dental midlines. After 16 months for detailing and finishing, the patient was debonded, and Hawley retainers were used for retention (Figure 7). The total treatment duration was 28 months. The skeletal and dental conditions were stable after 2 years of follow-up (Figure 8).

Figure 4. A Lateral cephalometric film, B panoramic radiographs before surgery and after presurgical leveling.
Figure 5. Facial and intraoral photographs, after OGS.

Figure 6. A Lateral cephalometric film, B panoramic radiographs after completion of treatment.
Figure 7. The intraoral photographs, after treatment.

Figure 8. The facial and intraoral photographs in 2 years after debond.
TREATMENT RESULTS

The facial profile, excess vertical facial height, and anterior open bite were improved (Figure 8). A normal overbite, overjet, Class I canine relationships, and coincident facial and dental midlines were achieved (Figure 9). A considerable increase in the nasolabial angle was observed. The flat labiomial fold was changed to an acceptable contour. The superimposition of cephalometric tracings revealed that the maxilla had advanced, thereby improving the paranasal depression. The impacted posterior maxilla was affected by changes in the occlusal plane and improvement in the reverse smile arc. The anterior nasal spine osteotomy was performed to prevent widening of the nose. The mandible was set back to eliminate the mandibular prognathism. Genioplasty was performed to improve the chin contour. Cephalometric analysis comparing the initial and final conditions indicted that the ANB angle increased from -5.1° to 3.8°. The angle between the maxillary incisor and S-N plane decreased from 109° to 102.9°. The mandibular incisor to mandibular plane angle increased from 74.7° to 89.2° (Figure 10 and Table 1).

DISCUSSION

Accurate diagnosis of the skeletal and dentoalveolar components of Class III malocclusion, including maxillary deficiency, mandibular prognathism, or a combination of both, is essential for accurate planning and effective treatment. Anterior open bite varies from case to case and is one of the most challenging dentofacial deformities to treat. If severe skeletal class III malocclusion is combined with anterior open bite, orthodontic correction is further complicated. Several cases have recently been reported in which mandibular setback combined with TADs for maxillary molar intrusion to reduce the posterior vertical dimension instead of using maxillary surgical impaction. This method was reported as less invasive and effective alternative other than the two-jaw surgery. However, this procedure cannot resolve midfacial deficiency. In addition, long-term reports indicated that the relapse rate for orthodontic molar intrusion is about 30%. Park et al. reported that 2 to 3 mm of posterior teeth intrusion can be obtained easily and precisely using TADs. While cases of severe anteroposterior discrepancy and vertical maxillary excess still require skeletal posterior maxillary impaction. This procedure increases the amount of surgical mandibular setback and distal movement of the chin by changing the occlusal plane in a clockwise direction. In this case, clockwise rotation of the MMC was performed using LeFort I osteotomy and BSSO to achieve better facial balance.

Preoperative orthodontic decompensation treatment could increase the severity of the Class III malocclusion and facial profile. The quality of preoperative dental decompensation determines the quality, quantity, and type of OGS, was considered as one of the factors to the success of the treatment. In this case, decompensation of the maxillary and mandibular arches, without extraction, required 12 months. The overjet changed from -6 mm to -12 mm. The large negative overjet increased the amount of surgical mandibular setback.

Several additional orthodontic parameters must be considered while planning dental decompensation before orthognathic surgery. The inclination of the anterior teeth would change after surgical alteration of the occlusal plane angle. If the maxillary occlusal plane angle is to be altered using counter-clockwise rotation, the angulation of the upper anteriors should be decreased before surgery. In other hand, if the maxillary occlusal plane angle is altered clockwisely, the angulation of the upper anteriors should be increased before surgery. However, if the maxilla is segmentalized, the surgeon could change the angulation of the maxillary anterior teeth with wider range. In the case presented here, the angulation of the upper anteriors decreased from 109° to 103° because of clockwise rotation of the maxilla. It also contributes to the improvement of the smile arc from from flat to favorable.
Figure 9. The study models, after treatment.

Figure 10. Superimposition of cephalometric tracings. Black line, before treatment; red line, after treatment.
Only a few cases in the literatures described the stability of the changes after clockwise or counterclockwise rotation of the jaws. Chemello et al. and Reynke et al. reported stable results after both clockwise rotation and counterclockwise rotation of the MMC. However, Schendel and Epker reported that postsurgical stability is poor after counterclockwise rotation of the mandible. This resulted from the procedures to increase in the posterior facial height and stretching of the pterygo-masseteric musculature. In our case, clockwise rotation of the maxilla and slight counterclockwise rotation of the mandible with BSSO setback were performed. This procedure neither changed the posterior facial height nor stretched the pterygo-masseteric musculature.

In this case, we stripped the muscle and ligament attachment to the medial side of the mandibular angle. This procedure allowed greater mandibular distal segment setback and prevented rotation of the proximal segment posteriorly, which might decrease postsurgical stability. BSSO osteotomy should be secured with rigid fixation. The changes in proximal segments might tend to return to their presurgical position following surgery. In addition, Proffit et al. reported that there is better control of the ramus position when two-jaw surgery is performed. In this case, the ramus position was not changed and the condyle was in the glenoid fossa. After 2 year follow up after surgery, a stable skeletal relationship and occlusion were maintained.

Sarver reported that clockwise rotation of the occlusal plane can improve a flat or reverse smile arc. Tooth display relative to upper lip relation is important during smile. In this case, clockwise rotation of the maxillary occlusal plane was performed to achieve a better smile.

Mandibular setback could increase the depth of labiomental fold and increase facial convexity. Vertical shortening of the chin can also increase the fold depth and chin projection. Gallagher et al. reported that soft tissue advancement was greater in patients who had both anterior chin repositioning and vertical chin reduction than in those who had only anterior chin repositioning. Performing both mandibular setback and vertical chin reduction together has been reported to double the effect to deepening of the labiomental fold. Hence, without a proper treatment plan, mandibular setback combined with superior–anterior repositioning of the chin may result in overcorrection of the chin prominence. In our case, the patient had mandibular prognathism and long lower anterior face with a long and flat chin. Thus the mandibular setback combined with superior–anterior chin reposition genioplasty was performed to achieve a balanced facial profile.

In this patient, black triangles developed in the mandibular incisors. Black triangles, or open gingival embrasures, are an undesirable outcome of orthodontic treatment. Black triangles are more frequent in adult patients than in younger patients and are associated with alveolar bone resorption. Kim et al. reported that in surgical skeletal Class III patients, vertical alveolar bone loss was more severe in the mandibular incisors than in the maxillary incisors. In a 3D cone beam CT study, the authors observed that lingual alveolar bone loss increased during orthodontic treatment. In another study, the same authors reported that excessive forward movement of the lower incisors during pre-surgical orthodontic treatment results in alveolar bone loss around the incisors. Therefore, extra attention should be paid to reduce the risk of alveolar bone loss. If the symphysis is narrow and high and the mandibular incisors undergo pronounced sagittal movements and derotation, progressive bone loss may occur over the lingual and labial cortical plates during orthodontic treatment with a fixed appliance. Liou et al. also reported that orthognathic surgery triggers a 3- to 4-month period of higher osteoclastic activities and metabolic changes in the dentoalveolar region; it may be also be one of the reason for alveolar bone loss.
CONCLUSION

Skeletal Class III malocclusion combined with anterior open bite is difficult to treat. In this case, the patient was corrected with two-jaw surgery, excellent facial profile and dental relationship was achieved. Clockwise rotation of the occlusal plane can increase the amount of surgical mandibular setback and distal movement of the chin. Mandibular setback can also deepen the labiomental sulcus to correct a long, flat chin, achieving a balanced facial profile. Factors that cause black triangles should be considered, and communication with patients before treatment is very important.

REFERENCES


