INTRODUCTION

Skeletal Class III discrepancy includes maxillary retrognathism, mandibular prognathism, or a combination of both.\(^1\) The prevalence of Class III malocclusion is higher in Asian than in Caucasian populations.\(^2\)

Furthermore, the severity of skeletal Class III malocclusion is more marked in Asian populations, often requiring two-jaw surgical correction.\(^3,4\) In modern orthodontics, cone-beam computed tomography is a useful imaging tool to survey the bony deformity in order to plan appropriate surgical procedures.
Treatment options for adult skeletal Class III malocclusions include orthodontic camouflage or orthodontic treatment combined with orthognathic surgery. The choice between surgery and non-surgical orthodontic treatment for adult Class III patients should base on complete evaluation and diagnosis. In additional to sagittal discrepancy, the vertical problem of anterior or lateral open bite often complicates the treatment decision. We present a sequential surgical and orthodontic treatment of an adult patient with severe skeletal Class III deformity and an anterior open bite. The surgery included LeFort I maxillary osteotomy and bilateral sagittal split osteotomy (BSSO) in the mandible with clockwise rotation of maxillomandibular complex (MMC), as well as osseous genioplasty for chin advancement. Post-treatment results showed a harmonious facial profile, curved smile arc, as well as stable dental and skeletal relationship.

CASE PRESENTATION

An 18-year-old female patient reported experiencing difficulty biting off food with her front teeth and a long lower jaw. She denied history of major systemic diseases and facial trauma.

The frontal view demonstrated a longer lower facial third, lip incompetence with mentalis strain, and a flat smile arc with no major facial asymmetry. The upper and lower dental midlines coincided with the facial midline. A lateral view showed midface deficiency with mandibular prognathism and an acute nasolabial angle (Figure 1).

Intraoral examination revealed a Class III canine and molar relationship on both sides, as well as an anterior cross bite and open bite. Moreover, the lower arch was ovoid and narrow, with lingual tipping of the molars. The upper arch form was square in shape.

Figure 1. Pre-treatment facial and intraoral photographs.
Panoramic radiographs revealed four impacted wisdom teeth. Lateral cephalogram examination demonstrated that the patient had a skeletal Class III deformity, with proclined maxillary incisors and retroclined lower incisors (Figure 2 and Table 1).

The patient was diagnosed with a skeletal Class III relationship, with midface deficiency and mandibular prognathism, as well as Angle’s Class III malocclusion with an anterior open bite.

**Figure 2.** (A) Lateral cephalometric film. (B) Panoramic film before treatment.

**Table 1.** Comparisons of pre-treatment and post-treatment cephalometric analysis.

<table>
<thead>
<tr>
<th></th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
<th>Norm</th>
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<tbody>
<tr>
<td><strong>Skeletal</strong></td>
<td></td>
<td></td>
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<tr>
<td>SNA°</td>
<td>81.5</td>
<td>85</td>
<td>79.8 - 83.2</td>
</tr>
<tr>
<td>SNB°</td>
<td>87</td>
<td>82</td>
<td>75.7 - 78.1</td>
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<tr>
<td>ANB°</td>
<td>-5.5</td>
<td>3</td>
<td>3.2 - 5.0</td>
</tr>
<tr>
<td>SN-MP°</td>
<td>31</td>
<td>33.8</td>
<td>33.8 - 38.4</td>
</tr>
<tr>
<td><strong>Dental</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U1 to NA (mm)</td>
<td>8.5</td>
<td>5</td>
<td>4.3 - 8.1</td>
</tr>
<tr>
<td>U1 to SN (°)</td>
<td>122</td>
<td>105</td>
<td>103.85 - 108.75</td>
</tr>
<tr>
<td>L1 to NB (mm)</td>
<td>6</td>
<td>6</td>
<td>5.4 - 10.2</td>
</tr>
<tr>
<td>L1 to MP (°)</td>
<td>90</td>
<td>91.5</td>
<td>93.4 - 99.2</td>
</tr>
<tr>
<td><strong>Soft Tissue</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>E-line (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper</td>
<td>-6</td>
<td>-2</td>
<td>0.7 - 3.1</td>
</tr>
<tr>
<td>Lower</td>
<td>+2</td>
<td>-1</td>
<td>0.2 - 3.4</td>
</tr>
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TREATMENT GOALS AND PLAN

The treatment objectives included:
1. Correct midface deficiency and mandibular prognathism.
2. Correct dental compensation and inclination.
3. Achieve a bilateral Class I canine and molar relationship.
4. Improve her facial profile, lip posture and smile arc.

Based on the diagnosis, treatment goals, and the patient’s primary concerns, the following treatment plan was presented:
1. Orthognathic surgery to improve her facial profile.
2. LeFort I advancement with posterior maxillary impaction with clockwise rotation of the maxilla and BSSO for mandibular setback.
3. Post-surgical orthodontic treatment for leveling and alignment and to achieve satisfactory interdigitation.

TREATMENT PROGRESS

A week prior to surgery, we performed presurgical orthodontic preparation, which included full-mouth bonding and wire consolidation to prevent the bracket falling into the patient’s airway during surgery. In this surgery-first case, dental model was used to simulate treatable post-surgical occlusion. The surgical occlusion setup open contact in the posterior teeth to avoid unpredictable surgical interferences.

The LeFort I osteotomy was performed on the maxilla, with 2-mm advancement and 5-mm posterior impaction. BSSO was performed bilaterally on the mandible, with an 8-mm setback. Additionally, osseous genioplasty was performed to improve the chin contour.

Postoperative orthodontic treatment was initiated 1 week after surgery. The treatment involved leveling and alignment with sequential wire changes. Inter-arch elastics were used for correction of the posterior open bite and cross bite. At 13 months after surgery, the orthodontic treatment was completed (Figure 3,4).

Figure 3. Facial and intraoral photographs after treatment.
Figure 4. (A) Lateral cephalometric film after operation. (B) Lateral cephalometric film after treatment. (C) Panoramic film after treatment.
TREATMENT RESULTS

The lateral facial profile, chin prognathism, and anterior open bite of the patient were corrected. The nasolabial angle was markedly increased. The patient also displayed a consonant smile arc. Intraoral examination revealed a bilateral Class I canine and molar relationship, as well as normal overjet and overbite. Dental midlines coincided with the facial midline. Cephalometric analysis revealed ANB angle improvement from -5.5° to +3°. The angle between U1 to SN had decreased by 17°; moreover, the angle between L1 to MP had increased by 1.5° (Figure 5 and Table 1). The patient expressed satisfaction with the outcome.

Figure 5. Overall and regional superimpositions of pre-treatment and post-treatment lateral cephalometric tracings. Blue line, pre-treatment; green line, post-operation; red line, post-treatment.
DISCUSSION

Severe skeletal Class III deformity with an anterior open bite poses a treatment challenge, and involves anterior-posterior, transverse, and vertical control of the teeth and skeleton. In the evaluation of the anterior-posterior aspect, two-jaw surgery with maxilla advancement can resolve midfacial deficiency. Two-jaw surgery is also recommended over one-jaw surgery for greater ANB angular correction, particularly in cases with severe skeletal Class III discrepancy. Clockwise rotation of the MMC and occlusal plane can correct the proclination of the upper incisors and can improve the flat smile arc. In addition, clockwise rotation of the MMC can lead to a greater amount of mandibular setback and improved facial esthetics. Due to the invasive nature of two-jaw surgery, several studies have suggested the use of maxillary molar intrusion with temporary anchorage devices as an alternative to LeFort I osteotomy for maxilla impaction. However, maxillary molar intrusion cannot resolve midfacial deficiency and poses the risk of apical root resorption. In this case, we performed two-jaw surgery with maxilla advancement and clockwise rotation of the MMC to achieve better esthetic results.

From the transverse view, in patients with mandibular prognathism, some studies have noted the development of buccal tipping of the upper posterior teeth and lingual tipping of the lower posterior teeth, to maintain masticatory function. In skeletal Class III patients, transverse dental compensation is closely related to sagittal and transverse skeletal discrepancy. In surgery-first orthognathic cases, dental compensation of the upper and lower posterior teeth in the transverse section may cause occlusal interference during surgery. After surgery, the inter-arch cross-elastics were applied to correct the transverse dental compensation of posterior teeth. The posterior open bite was setup for surgical occlusion to avoid unpredictable occlusal interference and unexpected post-surgical anterior open bite.

In a vertical view, open bite can be categorized into skeletal open bite and dental open bite. However, it is difficult to make a differential diagnosis between these categories, because the clinical features often entail a combination of both factors. Hence, evaluating soft tissue, skeletal features, as well as dental features can clarify the identification of an open bite tendency. The etiologies of an anterior open bite are mainly classified into three groups: anatomical, environmental, and genetic factors. In the present case, the anatomic features of the skeletal open bite were an abnormal lower gonial angle value and overbite depth indicator (ODI) as shown in Figure 6 and Table 2. A greater lower gonial angle indicates more vertical growth of the mandible and an increased lower anterior facial height. In terms of environmental factors, tongue thrusting was observed, along with step-up in the upper anterior incisor region, the open bite was mainly limited at the anterior teeth. To resolve the habit of tongue thrusting, we bonded a lingual button over the palatal side of the upper incisor as a reminder of tongue position. During orthodontic treatment, we guided and checked the patient’s tongue position at every appointment. The use of positioners for finishing or retention offers advantages in preventing open bite. No genetic factors were involved, based on the family history of this case. Hence, we corrected the anterior open bite with clockwise rotation of the maxilla by LeFort I osteotomy. Another factor influencing postsurgical instability was posterior facial height (PFH) enhancement. In our case, we retained PFH to achieve a stable result.

When deciding between surgery and orthodontic camouflage treatment for skeletal Class III patients, the patient’s chief complaints, facial profile, limitation of teeth movement, and severity of bony discrepancy should be taken into consideration. A recent study reported six cephalometric measurements (overjet ≤ -4.73 mm; Wits appraisal ≤ -11.18 mm; L1-MP angle ≤ 80.8°; Mx/Mn ratio ≤ 65.9%; overbite ≤ -0.18 mm; and gonial angle ≥
Table 2. Cephalometric Measurements related to skeletal open bite.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Pre-treatment</th>
<th>Norm</th>
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<tbody>
<tr>
<td>UAFH / LAFH</td>
<td>87%</td>
<td>70% - 90%</td>
</tr>
<tr>
<td>PFH / AFH</td>
<td>70%</td>
<td>64.19 ± 6.94%</td>
</tr>
<tr>
<td>Y-AXIS</td>
<td>64.5</td>
<td>53 - 66°</td>
</tr>
<tr>
<td>Lower Go angle</td>
<td>78.5</td>
<td>70 - 75°</td>
</tr>
<tr>
<td>Overbite depth indicator</td>
<td>60.3</td>
<td>74.5 ± 6.07</td>
</tr>
</tbody>
</table>

Figure 6. Cephalometric evaluation of skeletal open bite.
120.8°) that can be used to determine whether surgical intervention is appropriate in borderline cases. Surgical treatment is recommended if the patient meets at least four of the six criteria. In this case, the patient met four of the criteria (overbite: -1 mm, Mx/Mn ratio: 61.6%, Wits appraisal: -15 mm, gonial angle: 122°) and she agreed with surgical orthodontic treatment.

CONCLUSION

In adult skeletal Class III patients with an anterior open bite, orthodontists must know the etiology, treatment sequence, and surgical pattern before starting surgical orthodontic treatment. An accurate diagnosis and treatment plan alongside effective communication between the patient, orthodontist, and surgeon are essential for successful outcomes in such cases.

REFERENCES


