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Correction of Skeletal Class III Malocclusion with Four Missing Premolars by Surgery-First Approach

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INTRODUCTION

For a severe skeletal Class III malocclusion with prognathic profile, the orthodontic treatment combined with orthognathic surgery could be an ideal approach to improve both the occlusion and the facial profile. However, traditional pre-surgical orthodontic decompensation usually takes 15 to 24 months to accomplish; patients may suffer from difficult eating and poor esthetics.¹

The case report presented a case with unfavorable dish-in profile and poor oral function which resulted from four missing premolars and severe mandibular prognathism. Two-jaw orthognathic surgery with the surgery-first approach (SFA) was performed to improve the sagittal and vertical proportion of the maxilla and mandible. The facial and lip profile was greatly improved. The post-surgical orthodontic treatment was focus on the proper dental inclination of both upper and lower dentitions with pre-adjusted bracket system.

The interdisciplinary collaboration of surgical orthodontics efficiently enhance the harmonized facial profile, functional occlusion and pleasing smile in a reasonable treatment duration.

Keywords: surgery-first approach (SFA); missing four premolars; severe retroclined incisors; multi-loop edgewise archwire; anterior root-torquing auxiliary wire (ART).
CASE REPORT

The young women came with chief complaints of prominent chin and facial asymmetry. Family history of protrusive lower jaw was noted in her father and grandmother. The initial facial photographs revealed flat infra-orbital prominence, mandibular deviation to left side and extremely dish-in profile (Figure 1). The intraoral findings included congenital missing of a premolar in each quadrant, mild crowding in the upper and lower arches, spacing between #43 and 44, upright upper anterior teeth and severe lingual inclined lower teeth (Figure 2). The dental cast indicated the molar relation were Angle’s Class III relationship in both sides. The overjet was -3 mm, the overbite was 3 mm (Figure 3).

The cephalometric measurements were presented in Table 1. Sagittally, the jaw relation indicated Class III jaw relationship with under-developed maxilla and mandibular prognathism. Vertically, decreased lower anterior facial height with low mandibular plane angle were noted.

Dentally, the upper incisors were significantly retruded. Patient’s U1-PP, U6-PP, L1-MP and L6-MP were all smaller than the norm. The interincisal angle was found larger than normal value (Table 1).

In soft tissue profile, the patient had a normal nasolabial angle, and both upper and lower lips were retrusive to E line (Figure 4).

Diagnosis

The patient was diagnosed as skeletal class III mandibular prognathism with midface retrusion, hypodivergent facial type; Angle Class III molar relation with anterior cross bite with retroclined upper and lower incisors due to tooth missing and dental compensation to the mandible prognathism.

Treatment plan

The patient had severe mandibular prognathism. The profile correction became her primary concern. Orthognathic surgery combined with orthodontic treatment became patient’s first choice. Correction of dental decompensation of retroclined lower incisors could be time-consuming that might deteriorate the chewing ability and facial profile. SFA rather than conventional orthognathic surgery was performed.

Figure 1. The 21 years old female had long lower jaw with prominent chin projection. Her infraorbital region was flat. Th tooth display was insufficient in upper incisor and complete in lower incisor when pose smile. Her lateral profile was concave. These were common features presented mandibular prognathism.
Figure 2. There is tooth missing of a premolar in each quadrant. No crowding of her upper dentition with upright incisors and retroclined lower incisors. Dental space between #43 and #44 were also noted. The anterior teeth demonstrated crossbite with the lower dental midline deviation to her left side.

Figure 3. The molar relation were Angle’s Class III relationship in both sides. The overjet was -3 mm, the overbite was 3 mm.

Figure 4. Tooth missing of 4 premolars were confirmed. The #48 presented in small size, the rest of third molars were missing. The bilateral mandibular condyles were slender but generally intact surface cortex. Both the upper and lower lips were retrusive to E line with -7 mm and -4 mm respectively.
The patient’s treatment included two disciplines; the order of treatment will be orthognathic surgery followed by orthodontic mechanotherapy. The surgical protocol was two jaws surgery to correct jaw position first. Three-dimensional (3D) computer-aided surgical simulation was performed to predict the skeletal and profile change after surgery. The idea profile was predicted and planned for Le Fort I osteotomy to advance ANS 4.9 mm, downgraft ANS 2.5 mm, impact right posterior 0.7 mm and left posterior 1.7 mm. The U1 was moved to left 0.5 mm, the posterior maxilla was move to right by 0.5 mm. In the mandible, BSSO was planned to setback Pog 6.1 mm and move Pog to right by 0.3 mm. In order to soften the originally prominent chin projection and increased the lower third facial height, a setback genioplasty was executed to decreased chin projection and achieved better symmetry (Figure 5). Orthodontic treatment with pre-adjusted bracket system was applied to correct tooth inclination and torque before space closure.

**Treatment progress**

During full mouth bonding with 0.022 x 0.028 slot OPA-K system, the brackets position and wires were placed passively. The actual surgical changes consisted of maxillary LeFort I advancement 2 mm, downward movement 2.5 mm and differential bilateral sagittal split setback (R’t side : 4.9 mm; L’t side : 5.5 mm) on the mandible. Facial contouring and genioplasty for chin downward lengthening with 3 mm interposition bone graft (Figure 6). The post-surgical occlusion was set at an end-on Angle’s Class II molar relationship with an anterior overjet of about 4–5 mm.

*Figure 5.* The 3D simulation of skeletal change before and after surgery in different views. The amounts of skeletal movement were measured.
Figure 6. Superimposition of initial and post-surgery tracings. Local regional superimposition (c) was registered on lower first molar and incisor to display the changes at chin projection and lower border of the mandible.

Figure 7. Three weeks after surgery, active orthodontic treatment was started with round-wire leveling. The patient was instructed to wear posterior up and down box-form elastics to correct the buccal open bite occurred in upper and lower posterior teeth. The bracket positions of #11,12,21,22 were placed in a higher level for upper anterior teeth for extrusion and maintain incisor display after orthodontic treatment. Mild swelling of the soft tissue was noted (a), but the profile became harmonious (b).
Three weeks after surgery, initial orthodontic leveling and alignment was carried out, the patient was instructed to wear posterior up and down box-form elastics (Figure 7). In the upper arch, the main archwire was subsequently changed to 0.019 x 0.025 TMA with exaggerated curve of Spee. Anterior root torquing spring (ART) was then attached onto the archwire in order to reinforce lingual root torque on the upper anterior teeth (Figure 8). The ART was made with 0.014 SSW in a hexagon form, the radially extending U-shaped bent portions are detailed to be substantially coplanar relative to each other, the ends of the integrally formed wire includes hooked end portions for engagement with a main dental arch wire.²

The multiloop edgewise archwire (MEAW, 0.016 x 0.022 SSW) was inserted in the lower dentition to level the curve of Spee and to procline lower anterior teeth (Figure 8). Using MEAW to gain buccal crown torque of lower teeth was effective. The buccal expansion of lower dentition was displayed in Figure 9.

![Figure 8. Upper arch, #13–33 anterior root torquing spring (ART); lower arch, multiloop edgewise archwire (MEAW, 0.016 x 0.022 SSW). Noted the brackets of upper incisors were rebonded to a lower level closer to occlusal side, so that the torque expression of ART could be increased.](image)

![Figure 9. Progressive occlusal change after surgery. The labial crown torque of lower incisors has increased (B), overjet decreased and occlusal contact of posterior buccal segment were noted (A). After the torque of upper incisors was corrected, the incisors became more intruded relative to upper occlusal plane (C).](image)
Treatment results

The retroclined upper and lower incisors were mainly corrected with orthodontic archwires and preadjusted brackets. The curve of Spee was leveled well in both arches (Figure 10). The superimposition of post-operative and finished cephalometric tracings revealed the torque of anterior teeth was all improved (Figure 11). Normal interincisal angle was obtained and optimal overjet and overbite were achieved (Table 1). The total treatment duration was 19 months with both surgical and orthodontic interventions.

It was obvious to note the improvement of facial proportion mainly from orthognathic surgery. Normal infra-orbital prominence and straight profile were accomplished. The size reduction and vertical lengthening genioplasty was not only soften her chin projection but also increased the lower anterior facial height (Figure 13).

The finished panoramic radiograph showed good root parallelism and minor root resorption (Figure 14). The overall superimposition demonstrated the facial proportion was improved by sagittal jaw correction and increase the LAFH (Figure 15).

Figure 10. Change of curve of Spee.
A: Right after surgery, the curve of Spee of upper dentition was remained reversed (blue line).
B: The curve of Spee was leveled after active orthodontic treatment (red line).

Figure 11. The overall superimposition showed a counterclockwise rotation of mandible after orthodontic treatment (a). The SN-MP decreased about 1.5 degree. The regional superimposition of maxilla revealed the proclination of maxillary incisors (b). The regional superimposition of mandible revealed the mesialization of lower first molar and proclination of lower incisors (c).
Table 1. Cephalometric measurements in before and after treatment.

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Figure 12. Ideal overjet and overbite were achieved at completion of treatment. Angle’s Class I molar relationship was seen at both sides. The total treatment duration was 19 months.

Figure 13. The patient received an orthognathic surgery including LeFort I maxilla advancement and downward rotation, bilateral sagittal split mandibular setback with clockwise rotation of the maxillomandibular complex. Midface fullness and longer philtrum can be seen (a). Patient’s profile and chin projection were both improved and became harmonious (b). The incisor display was pleasing (c).
**Figure 14.** Panoramic film indicated closure of the space between #43, 44 and good root parallelism (a). The cephalometric film revealed straight profile, the upper and lower lips became minor retractive to E-line (b).

**Figure 15.** The overall superimposition of lateral cephalometric tracings. The SN-MP was increased after surgery but showed minor decrease after orthodontic treatment. The net increase of SN-MP was 6° (from 19° → 25°). The facial proportion was also improved. The final LAFH increased 3 mm.
DISCUSSION

In conventional orthognathic surgical procedures, the orthodontic preparation before surgery were usually time consuming. The pre-surgical dental decompensation may accentuate the imbalance of facial profile and decrease masticating efficiency of the patient. In this case, the SFA had indeed offered a better alternative to have an instant improvement of facial esthetics.

Initially, this patient not only had a prognathic mandible but also had an increased PFH/AFH ratio and UAFH/LAFH ratio. This indicated that the LAFH was deficient and needed to be enhanced with orthognathic surgery. To achieve this objective, the SFA is a fair option for the patient. In the cephalometric analysis, we found both the retroclined U1 and L1, the severe dental compensation was only in the lower dentition. She also had extreme thin mandibular symphysis and thin gingival biotype in anterior teeth. If we chose the conventional therapy, it took long time to decompensate the retroclined L1, create reverse overjet and close the space between 43 and 45. Besides, it might deteriorate the periodontal conditions. The presurgical orthodontic treatment may not help for the dental alignment and axial inclination correction in the front teeth.

Combination of mandibular setback and vertical lengthening genioplasty could increase in the lower anterior face height immediately and solve the mandibular overclosure at the same time. The facial profile could be predicted by 3D computer-aided surgical simulation (Figure 16). Besides, the surgeon’s technical proficiency coupled with secure rigid internal fixation could stabilize the posterior vertical control in early treatment stage.

Patient’s distinct chin projection was resulted from severe mandibular prognathism. Genioplasty could be a stable and easier surgical option to change facial profile and provide reliable results. Nowadays the genioplasty has developed to different surgical objectives. The procedure of chin reduction, set back and downward rotation provide correction the labiamental curvature and increase the lower anterior facial height concomitantly.

The patient had congenital missing premolar in each quadrant. The orthodontic management of severe retroclined upper and lower incisors (U1-SN : 99°, L1-MP : 72°, Table 1) might be a great challenge even for orthodontic treatment along. In this case, ART was used in the upper arch to apply lingual root torque on a group of teeth by combined with short Class II elastics.

MEAW was used in the lower arch. The multiple L loop between the teeth could reduce the load deflection rate (LDR) of the archwire and allow independent tooth movement. The multiloop edgewise archwire demonstrated a great buccal expansion effect for the lower dentition. In this case, the archwire was equipped without compensating bend, lack of lingual crown torque, and having no toe in bend. This arrangement also helped to procline the lower incisors (Figure 9).

The occlusion after surgery might become unstable temporarily. The rigid internal fixation stabilized the osteotomized bony segments. The postoperative rapid orthodontic tooth movement lasted 3~4 months. The orthodontic mechanotherapy should be started no later than 2 weeks after surgery. The appointment interval can be set about 2~3 weeks. With the help of regional acceleratory phenomenon (RAP), the total treatment time could be shortening.

The clockwise rotation of maxilla-mandibular complex could increase the upper incisor show. The skeletal vertical height was sustained with rigid internal fixation. The molar relationship became an end-on Angle’s Class II with anterior overjet about 4~5 mm before active orthodontic treatment (Figure 6).

Normally the ideal incisal edge of the upper incisor lies 2 to 3 mm below the upper lip at rest. In this case, upper incisor show became 1 mm decrease after post-surgical orthodontic treatment. The decreased incisor show was an unaesthetic change. The change came from leveling the curve of Spee and proclination of upper
incisors. The predicted post-surgical dental movement could be integrated into surgical simulation in SFA by extrusion more in the maxillary anterior region to compensate for the post-surgical dental movement.

In recent years, SFA has become an alternative treatment option of surgical orthodontics. The postoperative stability was still a main concern of the orthodontists. The overall superimposition of post-surgery and finishing indicated a counterclockwise rotation of mandible after postoperative orthodontic treatment. The SN-MP decreased about 1.5 degree. This might be due to the intrusion of lower molars even though the posterior vertical elastics were applied during the treatment. We speculated that strong jaw closing muscles of short face patients that caused the intrusion of the molars. On the other hand, the post-surgery occlusion was unstable with occlusal interference. The occlusal settling happened during postoperative orthodontic treatment. In this case, the post-surgery molar relationship was setup in Class II end on. After post-operative orthodontic treatment, the final occlusion became Class I molar relationship. The mandible exhibited counterclockwise rotation followed by mandibular forward movement.

Some studies also exhibits mandible postoperative forward movement during postoperative orthodontic treatment. The factors affected the stability of orthognathic surgery are many, including surgical factors and patient-related skeletal and dental factors. Ko et al. indicated the initial overbite may be an indicator to predict possible skeletal relapse of mandibular setback. A 1 mm greater initial OB in patients with Class III malocclusion contributed to 0.449 mm of mandibular sagittal skeletal relapse measured at the B point. Han et al. used a geometric method for prediction of mandibular forward movement resulting from postoperative mandibular counterclockwise rotation. Ricardo et al. proposed the single cephalometric measurement (Vr-Pg) related to skeletal relapse at 6 months after surgery (skeletal relapse at 6 months after surgery = 0.26 x mandibular setback).

Using the possible indicators related to skeletal relapse, we could propose the amount of inevitable mandibular forward movement and take it into consideration when making a surgical plan.

**CONCLUSION**

The 3D surgical simulation could accurately plan the correction of severe skeletal Class III with both sagittal and vertical problems and abnormal dental inclination. Different from conventional orthodontic-first approach, the SFA can correct the facial proportion prior to dental correction. The rigid internal fixation technique provides the stability of jaw position. Thus, the biomechanics that apply on orthodontic correction could be reliably delivered. Even in cases with severe dental compensation, the correction of dental inclination can be successfully achieved at post-surgical orthodontic treatment. The enhancement of chin reduction and down-grafting genioplasty creates a softening chin projection in patients with prominent chin contour.
Figure 16. With this 3D simulation, the soft-tissue morphing resulting from skeletal changes can be predicted and it could also help to demonstrate the surgery outcomes to the patient.

Figure 17. The frontal smile view.
Uneven muscle tension was noted in the post-surgical frontal smile view, and lip canting with different degree of elevation was noted. The incisor display and lip canting were both improved at finishing.

Figure 18. The superimposition of cephalometric tracing taking at finishing and after 3 years follow-up.
The overall results were stable. There was very minor relapse of the torque of upper and lower incisors.
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