Surgical repositioning of infra-ocluded dental implants in the orthognathic management of a Class III open-bite patient

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Dental implants placed in the maxillary anterior region have a high risk of aesthetic complications caused by later infra-occlusion and may subsequently require special therapeutic considerations to achieve optimal aesthetic and functional results. Based on the severity, possible treatment options for infra-ocluded implants include replacement of the implant restoration, alveolar distraction osteogenesis, repositioning by a segmental osteotomy, or the removal of the implant. The present case report describes the successful application of bi-maxillary orthognathic surgery combined with an anterior segmental osteotomy for the correction of a Class III open-bite malocclusion complicated by severely infra-ocluded implants.

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Introduction

There has been an increase in the number of adult orthodontic patients, many of whom have dental implants for the replacement of missing teeth. Accompanying the increase in implant usage, consequential orthodontic problems have arisen, one of which is a positional discrepancy between an implant and the adjacent teeth due to early implant placement in a patient whose growth was incomplete. Anterior implants placed during the late adolescent period are especially prone to later functional and aesthetic problems. Like ankylosed teeth, implants do not follow the vertical growth pattern of the alveolar process, and when implants infra-occlude, a vertical alveolar bone discrepancy, and a gingival margin discrepancy are unwelcome complications.1 When treating presenting patients, strategic orthodontic planning as well as surgical treatment options should be considered. Depending on the severity of the infra-ocluded implants and the desired final occlusion, existing dental implants may be removed and re-inserted, undergo replacement of the implant restoration, or the implant may be repositioned by a segmental osteotomy.

If the occlusal problem is minor and the existing implant is sound, modifying and replacing the implant prosthesis after orthodontic treatment may be an option. Severely mal-positioned implants, which cannot be treated by orthodontic nor prosthetic means, are often removed and re-inserted in a more suitable position. As an alternative to implant removal, which can lead to significant alveolar destruction in the aesthetically-important anterior segment, a segmental osteotomy is a treatment possibility that may improve levelling and alignment of osseo-integrated implants and ankylosed teeth.2 Surgical correction by a segmental osteotomy has been used to move malposed implants and ankylosed teeth in anteroposterior, vertical, or horizontal directions, thereby promising a more favourable aesthetic and functional result.
While a dentoalveolar osteotomy has been an option to correct the position of implants that could not be moved orthodontically, there have been few reported cases that describe the simultaneous levelling of mal-positioned implants, vertically under-erupted teeth and associated underdeveloped alveolus via an anterior segmental osteotomy. The present case report describes bi-maxillary orthognathic surgery combined with an anterior segmental osteotomy for the correction of a Class III open-bite malocclusion complicated by severely infra-occluded implants.

Case report

Case summary
A 20-year-old male presented with the chief complaints of an anterior open-bite and mandibular prognathism. There was a history of dental trauma to the anterior maxilla, which caused the loss of the upper incisors at 15 years of age, after which the patient received implant replacements at a local clinic. The patient was physically healthy and without an adverse medical history.

Pretreatment facial photographs revealed a concave profile with chin protrusion and a long lower facial height. Full smile photographs showed insufficient maxillary incisal exposure and a reverse smile arc. There was a Class III malocclusion with an anterior crossbite (-5.0 mm overjet), open-bite (-2.5 mm overbite), and a posterior crossbite on the right side. The lower dental midline deviated to the right side. The maxillary dental arch showed an accentuated curve of Spee, and the mandibular arch was broader than the maxillary arch (Figure 1).

A lateral cephalometric analysis indicated a skeletal Class III jaw relationship with mandibular prognathism, a high mandibular plane angle, and a compensated mandibular central incisor–mandibular plane angle. The maxillary central incisor implants and lateral incisors were infra-occluded, which produced two maxillary occlusal planes stepped between the lateral incisors and canines (Figure 2A, Table I). The posterior-anterior cephalogram indicated that menton was slightly deviated to the right side (Figure 2B). The panoramic radiograph verified that osseo-integrated implants were provided to replace the maxillary central incisors (Figure 2C).

Diagnosis
The case was diagnosed as a skeletal Class III malocclusion as a result of a prognathic mandible, a
Table I. Cephalometric measurements.

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Normal Mean</th>
<th>Normal SD</th>
<th>Pretreatment (20y)</th>
<th>Before surgery (21 y)</th>
<th>Post-treatment (21 y 6 mo)</th>
<th>Retention (22 y 6 mo)</th>
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<tbody>
<tr>
<td>Skeletal (anteroposterior)</td>
<td></td>
<td></td>
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<tr>
<td>ANB(°)</td>
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<td>1.80</td>
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<td>-3.64</td>
<td>2.25</td>
<td>2.23</td>
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<td>SNA(°)</td>
<td>81.30</td>
<td>3.10</td>
<td>83.77</td>
<td>84.19</td>
<td>85.44</td>
<td>85.62</td>
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<td>87.83</td>
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<td>83.39</td>
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<td>N-perp-point A(mm)</td>
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<td>-0.71</td>
<td>-0.80</td>
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<td>0.92</td>
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<tr>
<td>N-perp Pog(mm)</td>
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<td>14.46</td>
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<td>Skeletal (vertical)</td>
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<tr>
<td>SUM</td>
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<td>394.32</td>
<td>394.84</td>
<td>391.21</td>
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<tr>
<td>MxOP-FH</td>
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<tr>
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<td>Wits</td>
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<td>6.18</td>
<td>6.07</td>
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<tr>
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<td>8.67</td>
<td>2.59</td>
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<tr>
<td>TVL-Pog</td>
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<td>0.00</td>
<td>4.94</td>
<td>2.29</td>
<td>-4.00</td>
<td>-4.00</td>
</tr>
</tbody>
</table>

Means and SDs of normal Korean male adults.

Figure 2. Pretreatment radiographs. A, lateral cephalogram; B, postero-anterior cephalogram; C, panoramic radiograph.

high mandibular plane angle, and a dental Class III malocclusion with an anterior open-bite.

Treatment progress and results

Treatment was initiated according to the treatment objectives and treatment plan (Table II). Fixed pre-adjusted edgewise brackets with 0.022-inch slots were placed in both arches, and bands with rectangular tubes cemented on the maxillary first molars. Angulation control of the anterior teeth was required between the lateral incisor and canine to create space for intended vertical osteotomy sections. Modified bracket positioning was accommodated and used to
apply mesial root movement of the lateral incisors and distal root movement of the canines to widen the inter-radicular space. The maxillary dentition was segmented between the lateral incisors and the canines to facilitate differential movement between the anterior and posterior segments of the maxilla. The stepped occlusal plane and the inter-radicular space for the osteotomy were maintained by pre-surgical orthodontic treatment as revealed by the pre-surgical radiograph (Figure 3).

A downward and distal tipping of the anterior segment was performed to level the anterior and posterior segments of the maxillary dentition. A Le Fort I osteotomy involving a posterior impaction was performed to manage the open-bite. An asymmetric setback via a bilateral sagittal split ramus osteotomy and reduction genioplasty were performed to correct the chin prominence, chin deviation, and the long lower facial height.

Six weeks following the surgery, the segmented arch wire and final wafer were removed and a continuous arch wire was inserted. Post-surgical orthodontic treatment established and stabilised the Class I occlusion and secured a positive overjet with a focus on the control of the overbite.

After post-surgical orthodontic detailing, the facial profile with facial height and occlusion were seen to improve (Figures 4, 5). The total active treatment period was 19 months. At a one-year post-treatment examination, the patient had maintained a stable occlusion without significant relapse. No visible radiographic evidence of pathologic change in the teeth nor surrounding periodontal tissue adjacent to the vertical osteotomy line was apparent (Figures 6, 7).

### Table II. Treatment objectives and plans.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Objectives and plans</th>
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<tr>
<td>Pre-surgical treatment objectives</td>
<td>Perform alignment and levelling of anterior and posterior segments individually to maintain the pre-existing stepped occlusal plane in maxilla. Control the root angulation of the lateral incisors and canines with modified bracket positioning to obtain sufficient interradicular distance from the vertical osteotomy line. Achieve arch coordination by expansion of maxillary dental arch with a transpalatal arch.</td>
</tr>
<tr>
<td>Surgical treatment objectives</td>
<td>Maxilla Leveling of anterior and posterior segments by anterior segmental osteotomy for downward movement and palatal tilting of anterior segment. Le Fort I osteotomy with posterior impaction not only to decrease the amount of open-bite but to increase the amount of setback as well. Mandible Asymmetric setback by means of a bilateral sagittal split ramus osteotomy. Reduction genioplasty for correction of chin protrusion and long lower facial height.</td>
</tr>
<tr>
<td>Post-surgical treatment objectives</td>
<td>Achieve functional Class I occlusion with normal overjet and overbite.</td>
</tr>
</tbody>
</table>

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**Figure 3.** Intraoral photographs [A] and panoramic radiograph [B] at pre-surgical stage.
Discussion

The present case described a male patient who presented with a Class III anterior open-bite malocclusion that was treated by bi-maxillary orthognathic surgery, including an anterior segmental osteotomy to reposition infra-occluded upper anterior implants. Pre-surgical orthodontic treatment planning and comprehensive surgical preparation of the anterior segment guaranteed stability of the occlusion and successful facial improvement following surgery. In growing patients, osseo-integrated implants do not adapt to positional changes of the natural dentition. As they behave like ankylosed teeth, implants remain stationary and do not follow the growth of the alveolar process as the natural dentition continues to erupt. Particularly in the maxillary anterior region, vertical growth exceeds all other growth dimensions, therefore inappropriately timed and placed implants lead to infra-occlusion and a subsequent open-bite. Unfortunately, in the presented patient, the maxillary central incisors were replaced by implants before
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the completion of growth, following which, vertical alveolar development in the incisor area was inhibited and produced an anterior open-bite and a stepped occlusal plane between the lateral incisors and canines. Depending on the severity of the vertical discrepancy, several treatment options were considered. One was the simple replacement of the implant restoration, or a more complicated alternative was the possible removal of the implant and anterior segmental repositioning via an osteotomy. Considering the magnitude of the open-bite, the alveolar height of the incisor area, the existing crown shape, and skeletal discrepancy of the patient, repositioning of the implants by an anterior segmental osteotomy was considered the appropriate course of treatment.

For maximum surgical correction of the open-bite, segmental levelling and root angulation control were achieved during the pre-surgical orthodontic stage. One anterior segment, including the four incisors, and two posterior segments, including the canines to the second molars, were levelled separately to maintain the existing stepped occlusal plane. Concurrently,
a transpalatal arch was applied to maintain the intermolar width. In a consideration of the vertical osteotomy width between the lateral incisors and canines, bracket positioning was modified to produce 1.5 mm of inter-radicular clearance created by mesial root movement of the lateral incisors and distal root movement of the canines.\(^1\) The distance between the mobilised segments and the adjacent alveolar bone influences the contribution of bone grafts to improve healing.\(^{16}\) With increasing distance, the benefit of a bone graft also increases. In the present case, the palatal surface of the anterior segment and palatal surface of the posterior segment were in contact, and a bone graft was not required.

The success of an anterior segmental osteotomy is critically dependent on optimal preservation of blood supply to the mobilised and repositioned alveolar segment. It is imperative that the flap design is adequate to preserve as much of the vascularisation surrounding the segmental alveolar bone as possible.\(^{17,18}\) A bone segment requiring vertical and horizontal movement may be correctly positioned and treated by a buccal approach, and in this situation, the flap should be detached only from the buccal aspect. This allows the palatal periosteum to maintain vascular integrity, and hence reduce the risk of necrosis.\(^{19}\)

The stability of the mobilised block is an additional and important factor to support adequate bone segment healing. Screws, plates, pre-fabricated wafers and surgical fixation wires may be used as stabilising techniques for a segmental block with embedded implants.\(^6,18\) In the present case, Y-type rigid plates with screws were used for segment fixation. A prefabricated wafer and surgical fixation wires were also inserted to reduce the possibility of bone movement. Tight ligatures were placed between adjacent teeth on both sides of the vertical osteotomies. A year after debonding, the results were stable.

**Conclusion**

The present case report illustrates the successful application of bi-maxillary orthognathic surgery combined with an anterior segmental osteotomy for the correction of a Class III open-bite malocclusion and severely infra-occluded implants. A comprehensive consideration of the orthodontic treatment options and team surgical planning enabled the achievement of a stable, functional, and aesthetic result. This may serve as a clinical example of an anterior segmental osteotomy for the management of infra-occluded implants as well as ankylosed teeth.

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