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Orthodontic Correction of Bimaxillary Protrusion with Mini-screws in Class II Hyperdivergent Patient

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To achieve a harmonious profile with pleasant smile arc in Class II hyperdivergent adult cases has been a clinical challenge. Adequate retraction and intrusion of maxillary dentition as well as vertical control are the key factors to improve the smiling appearance and the facial profile. A 19-year-old female initially presented with lip protrusion, convex profile, retrusive chin, and a Class II malocclusion. The cephalometric analysis showed a Class II skeletal pattern (ANB = 9°) with high mandibular plane angle (SN-MP = 38°). The treatment plan included extraction of four first premolars for anterior teeth retraction as well as installation of three miniscrews in the maxilla as bony anchorage. Two miniscrews were placed into the infrrazygomatic crest of the maxilla and one was inserted in the sub-apical region of maxillary incisors for retraction, intrusion, and torque control of anterior teeth. Bimaxillary protrusion was improved and a stable occlusal relationship was established after treatment. The total treatment duration was 24 months. Cephalometric analysis showed significant intrusion and retraction of maxillary incisors as well as a slight counterclockwise rotation of the mandible. This case demonstrated that the combined use of upper posterior and anterior miniscrews could be an effective manner to treat Class II hyperdivergent adult case with dentoalveolar protrusion. (Taiwanese Journal of Orthodontics. 31(2): 115-126, 2019)

Keywords: Class II Bimaxillary Protrusion.

INTRODUCTION

In the orthodontic treatment of Class II malocclusion with hyperdivergent facial type, treatment modalities can be divided into camouflage treatment or orthognathic surgery. If clinicians choose the camouflage treatment option, appropriate intrusion and retraction of maxillary incisors, upper incisors torque control, and vertical control of upper and lower dentitions are all critical components of a successful treatment. Before the age of temporary...
anchorage devices (TADs), the camouflage treatment in non-growing patients can be very difficult and requires high patient compliance to the extraoral appliance for an ideal force system like J-hook or high pull headgear.\(^1\)\(^\text{-}^3\) Most Class II mechanics without TADs also cause lower molar extrusion along with posterior rotation of mandible, which is non-desirable in hyperdivergent cases. However, surgical morbidity and risk of nerve injury, as well as surgical costs are both other concerns regarding combined surgical treatment option. Recently, miniscrews have been used to correct vertical maxillary excess through the intrusion of maxillary incisors and molars. Substantial profile improvement could be achieved successfully through proper design of mechanics delivered by TADs.\(^4\)\(^\text{-}^5\)

This case report presents the orthodontic treatment of a 19-year-old female whose lip protrusion was corrected by retracting anterior teeth and intruding the entire maxillary dentition using posterior and anterior miniscrews. This retraction and intrusion of the upper anterior teeth mimics a maxillary anterior subapical osteotomy, and intrusion of the entire upper dentition mimics a Le Fort I impaction. Mandibular autorotation after maxillary dental intrusion contributes to better chin projection without orthognathic surgery.

**CASE REPORT**

This is a case of a 19-year-old female who came with her chief complaint of protrusive lips and malocclusion. She denied all major systemic disease and food/drug allergy. In the functional examination, no TMJ clicking sound was noted. No muscle and joint palpation tenderness were found. Past dental history showed that she had received restoration and scaling before. About family history investigation, she had a younger sister who also had dentoalveolar protrusion problem.

**Pre-treatment data**

**Extraoral examination**

The frontal view revealed mild facial asymmetry with larger left hemiface and chin deviation to the right side (Figure 1). No gummy smile was found on her full smile. Relatively to facial midline, upper dental midline shifted to her right side by 3 mm. From the lateral view, she exhibited a convex lateral profile with retrusive chin, an acute nasolabial angle, lip incompetence and mentalis strain on lip closure. Both upper and lower lips are very protrusive to E-line. No obvious occlusal plane canting was found.

**Intraoral examination**

Her overjet and overbite were both 2 mm. From the frontal view, lower dental midline shifted to left 4 mm in comparison to the upper dental midline (Figure 1). The lower arch was in palatal crossbite. From the occlusal view, the upper and lower arch forms were square. And for the space analysis, the upper arch was 5 mm and the lower arch was 1.5 mm insufficient. The buccal segment revealed Class II canine and Class I molar relationship on the right side. And Class II canine and molar relationships were on the left side.

**Radiographic findings**

In panoramic X-ray, there were multiple caries. The 38 and 48 were horizontally impacted. The morphology of TMJ showed no abnormal findings (Figure 2). From the lateral cephalogram, the patient exhibited a skeletal Class II facial pattern with a high mandibular plane angle. The axis of the upper incisors was within normal range and lower incisors were proclined (ANB: 9°; MPA: 38°; U1-SN: 109°; L1-MP: 104°). The upper incisors and molars were both over-erupted compared to normal values. (UADH: 32 mm; UPDH: 26 mm) (Figure 3, Table 1).

**Diagnosis**

Skeletally, the patient had a Class II relationship and a high mandibular plane angle. Dentally, she had Class II malocclusion. In soft tissue aspect, she had a convex profile with retrusive chin, and lip incompetence.
Class II Bimaxillary Protrusion

Figure 1. Pre-treatment extraoral and intraoral photographs.

Date: 2016/08/17
Age: 19Y7M
Series: Initial

Figure 2. Pre-treatment panoramic radiograph.
Table 1. Pre-treatment and post-treatment cephalometric measurements.

<table>
<thead>
<tr>
<th></th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
<th>Norm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SKELETAL ANALYSIS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SNA</td>
<td>90</td>
<td>90</td>
<td>81.5° ± 3.5</td>
</tr>
<tr>
<td>SNB</td>
<td>81</td>
<td>82</td>
<td>77.7° ± 3.2</td>
</tr>
<tr>
<td>ANB</td>
<td>9</td>
<td>8</td>
<td>4.0° ± 1.8</td>
</tr>
<tr>
<td>Nv-A</td>
<td>8</td>
<td>8</td>
<td>0.0 ± 2.0 mm</td>
</tr>
<tr>
<td>Nv-Pog</td>
<td>-5.2</td>
<td>-4.5</td>
<td>-5.0 ± 8.0 mm</td>
</tr>
<tr>
<td>SN-FH</td>
<td>8</td>
<td>8</td>
<td>5.7° ± 3.0</td>
</tr>
<tr>
<td>SN-MP</td>
<td>38</td>
<td>36</td>
<td>33.0° ± 1.8</td>
</tr>
<tr>
<td>UFH/LFH</td>
<td>44/56</td>
<td>44.3/55.7</td>
<td>45% / 55%</td>
</tr>
<tr>
<td><strong>DENTAL ANALYSIS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U1-SN</td>
<td>109</td>
<td>100</td>
<td>108.2° ± 5.4</td>
</tr>
<tr>
<td>U1-L1</td>
<td>110</td>
<td>133</td>
<td>119.9° ± 8.5</td>
</tr>
<tr>
<td>L1-MP</td>
<td>104</td>
<td>91</td>
<td>93.7° ± 6.3</td>
</tr>
<tr>
<td>UADH</td>
<td>32</td>
<td>30.4</td>
<td>29 ± 2 mm</td>
</tr>
<tr>
<td>UPDH</td>
<td>26</td>
<td>24.4</td>
<td>20 ± 2 mm</td>
</tr>
<tr>
<td>LADH</td>
<td>45.6</td>
<td>44.5</td>
<td>45 ± 3 mm</td>
</tr>
<tr>
<td>LPDH</td>
<td>34</td>
<td>34.8</td>
<td>35 ± 3 mm</td>
</tr>
<tr>
<td><strong>FACIAL ANALYSIS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-Line</td>
<td>5.6</td>
<td>1.5</td>
<td>2 ± 2.0 mm</td>
</tr>
<tr>
<td>Upper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td>11.2</td>
<td>6</td>
<td>1 ± 2.0 mm</td>
</tr>
</tbody>
</table>

Figure 3. Pre-treatment lateral cephalometric radiograph.
Treatment objectives and plan

The treatment goals were as the followings:
1. Improve protrusive facial appearance and lip posture through maximum retraction of the upper and lower anterior teeth.
2. Reduce the lower anterior facial height, and auto-rotate the mandible to strengthen the chin projection.
3. Correct dental midline.
4. Achieve bilateral Class I canine and molar relationships.

We proposed her the treatment plan to extract four third molars and four first premolars, along with installation of 3 miniscrews as bony anchorage. Two miniscrews were placed into the infrazygomatic crest for maxillary anterior retraction and vertical control. And one miniscrew was placed into the sub-apical of maxillary central incisors for retraction, intrusion, and torque control of upper anterior teeth.

Treatment progress and result

Before full mouth bonding, we referred the patient to remove all third molars and to have all cavities restored. Besides, orthodontic treatment was initiated after proper oral hygiene routine undertaken. After that, the .022 Damon Q self-ligating bracket system was bonded, except 12 (Table 2). Then, we extracted four first premolars and started canine distalization with lace back.

After space was sufficient for 12, we bonded 12 and used a double wire technique to level the lock-in lateral incisor. In the 7th month of treatment, we inserted the anterior subapical miniscrew in between the upper central incisors for intrusion and torque control of anterior teeth. In the 12th month of treatment, we inserted two miniscrews into the infrazygomatic crest for anterior retraction and vertical control of posterior teeth (Figure 4).

The total treatment duration was 24 months.

Figure 4. Mid-treatment extraoral and intraoral photographs (1Y8M).
### Table 2. Treatment progress.

<table>
<thead>
<tr>
<th>Date</th>
<th>Upper Arch</th>
<th>Lower Arch</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016.10.6</td>
<td>Bonding, .014 NiTi (bypass #12)</td>
<td>Bonding, .014 NiTi</td>
</tr>
<tr>
<td>2016.10.15</td>
<td>.016x.022 NiTi Ext #14</td>
<td>.016x.022 NiTi Ext #44</td>
</tr>
<tr>
<td>2016.11.5</td>
<td>.017x.025 NiTi Ext #24 Lace back for canine retraction</td>
<td>Ext #34 Lace back for canine retraction</td>
</tr>
<tr>
<td>2016.12.6</td>
<td>.016x.025 Cu-NiTi Bonding #12 eyelet and using double wire technique to level</td>
<td>.017x.025 NiTi</td>
</tr>
<tr>
<td>2016.12.27</td>
<td>Bonding #12 bracket .014 NiTi</td>
<td>PC 43-46 to correct midline</td>
</tr>
<tr>
<td>2017.1.21</td>
<td>.016 NiTi</td>
<td>.016x.025 NiTi 42 lingual bite built-up to facilitate crossbite correction</td>
</tr>
<tr>
<td>2017.2.9</td>
<td>.014x.025 Cu-NiTi</td>
<td>.017x.025 SSW</td>
</tr>
<tr>
<td>2017.3.4</td>
<td>Ant. subapical miniscrew insertion</td>
<td>Canine retraction</td>
</tr>
<tr>
<td>2017.4.8</td>
<td>.016x.022 SSW Canine retraction</td>
<td></td>
</tr>
<tr>
<td>2017.6.17</td>
<td>.017x.025 SSW add 12-22 labial crown torque remaining space closure</td>
<td></td>
</tr>
<tr>
<td>2017.9.21</td>
<td>L’t Class II elastics for midline correction</td>
<td></td>
</tr>
<tr>
<td>2017.10.31</td>
<td>Bilateral upper posterior miniscrews insertion for ant. retraction</td>
<td></td>
</tr>
<tr>
<td>2017.12.28</td>
<td>.017x.025 SSW ante teeth add lingual root torque</td>
<td>remaining space closure</td>
</tr>
<tr>
<td>2018.3.6</td>
<td>arch coordination, occlusal detailing and interdigitation, settling elastics</td>
<td></td>
</tr>
<tr>
<td>2018.4.3-2018.9.25</td>
<td>arch coordination, occlusal detailing and interdigitation, settling elastics</td>
<td></td>
</tr>
<tr>
<td>2018.10.11</td>
<td>Lingual fixed retainer delivery, full mouth debonding</td>
<td></td>
</tr>
<tr>
<td>2018.10.23</td>
<td>Deliver upper and lower wraparound retainers</td>
<td></td>
</tr>
</tbody>
</table>

**Total treatment duration: 2Y**
Class II Bimaxillary Protrusion

1. Upper incisors: retracted, intruded
2. Lower incisors: retracted, intruded
3. Upper molars: intruded
4. Lower molars: uprighted
5. MPA decrease

1. U1: retract 6.4 mm, intrude 1.6 mm
2. U6: intrude 1.6 mm

1. L1: retract 6.4 mm, intrude 1.1 mm
2. L6: uprighted

Figure 9. Cephalometric superimpositions. Overall superimposition registered at the cranial base and S point, maxillary superimposition using the structure method and mandibular superimposition registered on the anterior internal cortex of symphysis and mandibular lower border.
The dentoalveolar protrusion was resolved and a stable occlusion was established after treatment (Figure 5). Lingual fixed retainers were placed in both arches and removable wraparound retainers were delivered for retention.

The cephalometric analysis showed both upper and lower lips retracted after treatment. The U1-SN changed from 109 to 100 degrees and U1 was significantly intruded and retracted. U6 was intruded 1.6 mm and caused MPA changed from 38 to 36 degrees. It revealed the mandible had slightly counterclockwise rotation. It would further help improve the patient’s Class II appearance from augmentation of chin profile. L1-MP changed from 104 to 91 degrees, and L1 was retracted and intruded. The L1 intruded 1.1 mm may cause by leveling the lower curve of Spee during the anterior retraction (Table 1, Figure 9).
DISCUSSION

For patients who need to reduce tooth show from vertical excess problems, adequate intrusion mechanics should be chosen according to the needs respectively. The methods included using a conventional orthodontic appliance, such as intrusive arch or headgear and J-hook to apply intrusive force for upper anterior teeth. The intrusive arch could intrude the anterior teeth, and extrude, tip-back of posterior teeth at the same time. To prevent unwanted molars extrusion, we could lace the molars to posterior miniscrews or insert the intrusive arch directly to posterior miniscrews. However, the intrusive arch is a “shape-driven mechanics”. The force system changes according to the V bend position and angulation; the insertion site of the intrusive arch at the molar auxiliary tube or miniscrews also increased friction in sliding mechanics.

In this case, we combined used the bilateral miniscrews of the infrrazygomatic crest and anterior sub-apical miniscrew to retract, intrude and control the torque of maxillary incisors. Compared with the intrusive arch, the anterior sub-apical miniscrew can provide pure intrusive force to anterior teeth (force-driven mechanics). These mechanics do not have the side effect of extrusion and tip-back of posterior teeth which could make the chin profile worsened; neither does it cause any additional friction in the force system. During the intrusion of anterior teeth, we provided light retraction force to prevent unwanted root resorption and anterior flaring.

While using miniscrews to sustain the intrusive force, the appropriate biomechanical design is required for efficient incisor intrusion and less risk of root resorption. According to Lee et al., a good periodontal condition should be maintained during the intrusion. The force magnitude should be low and constant. The recommended force for the intrusion of the upper four incisors should less than 100 g. And periodical periapical X-ray check of root condition in every 4-6 months is recommended. If retraction is also undertaken at the same time, the retraction force could not be too heavy to prevent loss of anterior torque control. In this case, we use light force provided by an elastic thread from the archwire to the subapical screw. The force exerted through this approach has been shown to effectively provide constant force level below 100g. We found some root blunting in the upper anterior region in the post-treatment panoramic radiograph, which is acceptable considering the amount of intrusion performed.

Concerning the amount of intrusion of posterior teeth and its relapse rate, Yao et al. found the mean intrusive movement of the maxillary first molars was 3-4 mm. Baek et al. found the maxillary first molars were intruded by 2.39 mm during treatment and at the 3-year follow-up, and the relapse rate was 22.88% in open bite cases. Eighty percent of the total relapse of the intruded maxillary first molars occurred during the first year of retention. Sugawara et al. also found the average relapse rate was about 30% at the 1-year follow-up in open bite cases. However, in Class II hyperdivergent cases who need total maxillary intrusion to improve facial esthetics, the treatment result showed good stability after the retention period from 12-21 months. This might be owing to the etiological basis of different malocclusions, and their ability for neuromuscular adaptations. In our case, the upper molars were intruded 1.6 mm after the treatment. However, at the finishing stage, the patient showed good stability of the occlusion at each visit, under the cancellation of intrusive force for the upper dentition. Yet concerning the unpredictability of active retention protocol, we did not design any active retainer for the patient, further follow up for the patient’s stability is required (Figure 8).

In this case, U6 was intruded 1.6 mm after treatment, while the lower molars slightly extruded during uprighting after treatment. If we could maintain or even intrude the lower molars, the counterclockwise rotation of the mandible would be further maximized and
expressed thoroughly. However, if we take the patient’s facial proportions at frontal view into consideration, the treatment effect already turned her slight dolichofacial pattern into a mesofacial pattern, and her lower facial height proportions (subnasale-stomion/ stomion-menton) is already less than 1/2; it could be a worsening of facial esthetics if we increase the amount of intrusion for lower dentition regardless of facial proportions. Thus, more vigorous intrusion and counterclockwise rotation of mandible is not a treatment alternative for this patient.

According to Proffit’s “envelope of discrepancy”, maxillary and mandibular incisors could be retracted 7 mm and 3 mm maximally by orthodontic tooth movement alone. If tooth movement aided by miniscrews, a larger amount could be accomplished.\(^\text{16}\) In our case, the U1 and L1 both retracted 6.4 mm. Sarikaya et al. found that lingual movements of the maxillary and mandibular incisors reduced the lingual bone width in both arches.\(^\text{17}\) And some of the patients demonstrated bone dehiscence. Pan et al.\(^\text{18}\) found during anterior retraction, there is a risk for the U1 root to contact the incisive canal and might cause external apical root resorption.\(^\text{17}\) Wainwright found that once the cortical plate had been penetrated, the buccal root surface became devoid of cortical bone.\(^\text{18}\) Although some osteogenesis took place during the 4-month retention period, it was insufficient to cover the root completely.

If we look at the anterior alveolar ridge width and their relationship to mandibular symphysis and facial

\[\text{Date: 2019/04/02} \]
\[\text{Age: 22Y3M} \]
\[\text{Series: Post- Tx 6M} \]

**Figure 8.** Follow up extraoral photos and intraoral photos.
patterns, skeletal Class II hyperdivergent patients or the ones with thin symphysis width are the patients who own thinnest anterior alveolus width in maxilla and mandible, according to literatures. In these hyperdivergent cases, too much uprighted incisor inclination will result in fenestration at root apex, while buccal proclination will cause labial marginal bone dehiscence. From our post-treatment cephalometric radiograph, upper incisor position was still confined in the maxillary alveolus, while lower incisor was in contact with the lower lingual cortex. Besides, the total alveolar bone width harboring mandibular incisor roots is clearly very narrow, both in buccal and lingual directions, which indicates thinning of the alveolus in both arches during treatment. Although there are no signs of attachment loss/gingival recession from the latest follow-up records, we should keep careful monitoring the periodontal condition over lower incisors to prevent iatrogenic consequences in the long run. Furthermore, cone-beam computed tomography (CBCT) can aid in accuracy in evaluation of bone fenestration and boundary condition rather than cephalometry in the alveolar bone. Thus, if there’s no recovery of periodontal bone after the recall CBCT check, periodontal bone grafting will be indicated in reestablishing healthy periodontium in this case.

CONCLUSION

This case report demonstrated that the combined use of posterior and anterior miniscrews could be an effective protocol to simultaneously control the vertical dimension and resolve lip protrusion in a skeletal Class II hyperdivergent adult patient.

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