Non-extraction camouflage treatment using extra-alveolar skeletal anchorage

Young-Jun Lee,* Jae Hyun Park,† Na-Young Chang,‡ Kang-Gyu Lee§ and Jong-Moon Chae¶

Department of Orthodontics, School of Dentistry, University of Wonkwang, Iksan, Korea*
Orthodontic Program, Arizona School of Dentistry & Oral Health, A.T. Still University, Mesa, Ariz; International Scholar, Graduate School of Dentistry, Kyung Hee University, Seoul, Korea†
Department of Orthodontics, School of Dentistry, University of Wonkwang, Wonkwang Dental Research Institute, Iksan, Korea‡
Private Practice, Woo Bang Dental Clinic, Bundang, Korea¶
Department of Orthodontics, School of Dentistry, University of Wonkwang, Wonkwang Dental Research Institute, Iksan, Korea; Visiting Scholar, Postgraduate Orthodontic Program, Arizona School of Dentistry & Oral Health, A.T. Still University, Mesa, Ariz§

A 23-year-old female patient with moderate crowding and a bilateral molar scissor-bite was successfully treated without tooth extraction. Extra-alveolar skeletal anchorage, involving a three-dimensional key plate in the maxilla and two miniscrews in the buccal shelf of the mandible, were used for distalisation, buccolingual uprighting, and the intrusion of molars by fixed orthodontic appliances. Cone-beam computed tomography was used to identify available posterior space for the distalisation and buccolingual correction of the molars in scissor-bite. The total treatment time was 24 months. Post-treatment results showed good occlusal relationships and smile aesthetics. Twelve-month post-treatment records demonstrated no significant relapse and a favourable facial balance.

Introduction

Angle® introduced the concept of a line of occlusion, which postulated that arches can accommodate a complete dentition by bone growth stimulated by arch expansion, making the extraction of teeth unnecessary. However, Tweed‡ determined that the line of occlusion concept could result in complications related to protrusive faces and unstable dentitions. Therefore, it was concluded that a considered extraction treatment plan would improve the facial profile and stability of the dentition as well as treat an underlying malocclusion.

Dental crowding is a common chief complaint expressed by orthodontic patients. The severity of the crowding is an important factor in determining whether to plan extraction or non-extraction treatment. Proffit³ suggested that non-extraction treatment should be considered in cases with less than 4 mm of crowding and extraction treatment when more than 10 mm of crowding was present. This creates a “grey” area of borderline patients who have moderate crowding (4–10 mm) which then becomes a challenge to determine which treatment option (extraction or non-extraction) might be preferable.⁴ Therefore, in borderline cases,
the measurement of an arch length discrepancy and other factors such as patient compliance, facial profile, growth stage, and sagittal relationships should be carefully assessed.\(^5\)

An inappropriate non-extraction treatment plan can result in incisor proclination and lip protrusion.\(^5\)–\(^7\) Mandibular incisor proclination reduces the overbite and overjet but can result in instability of the dentition.\(^6\) Hence, incisor proclination should be limited by anatomic boundaries of the alveolar bone\(^8\) because bone dehiscence or gingival recession might occur when tooth movement exceeds these limits.\(^9\)–\(^10\) This means that distalisation of the posterior dentition is required to improve or maintain an acceptable facial profile and reduce potential complications in non-extraction patients.

With the advent of temporary skeletal anchorage devices (TSADs),\(^11\)–\(^19\) molar distalisation, as a component of non-extraction treatment, is becoming popular especially in cases of moderate crowding. TSADs are also helpful in treating a molar scissors-bite because of the possibility of simultaneous molar uprighting and intrusion.\(^16\),\(^17\) Recently, extra-alveolar TSADs\(^11\)–\(^18\) are being widely considered and used rather than inter-radicular TSADs\(^16\),\(^19\) so that the risk of root contact during distalisation and intrusion of posterior teeth is reduced. Using extra-alveolar TSADs, the present case report describes the non-extraction camouflage treatment of an adult patient who presented with moderate crowding and a bilateral molar scissors-bite.

**Diagnosis and aetiology**

A 23-year-old female patient presented with the chief complaint of crowding. Her medical history was unremarkable but she showed temporomandibular joint (TMJ) disc displacement with reduction and intermittent locking. After a year of splint therapy conducted in the department of oral medicine, the TMJ symptoms of pain and limited mouth opening improved and so the patient represented to the orthodontic department.

The patient showed a favourable facial profile but, from the frontal aspect, there was a slight chin deviation to the left. Intraoral photographs and dental casts revealed tooth size-arch length discrepancies (TSALDs) of 8.5 mm in the maxilla and 8.0 mm in the mandible. The dental midline had deviated by 1.5 mm to the right in the maxilla and 1.0 mm to the left of the facial midline in the mandible. There was also a bilateral molar scissors-bite (Fig. 1).

![Figure 1](image-url)
A lateral cephalometric analysis indicated a mild dental and skeletal Class II relationship (ANB, 4.7°), a hyperdivergent facial pattern (FMA, 31.0°), normal inclination of the incisors (U1- FH, 110.6°; IMPA, 93.3°), and verified excellence of the facial profile (UL/EL, 0.4; LL/EL, 1.8). A panoramic radiograph confirmed the presence of three third molars except in the maxillary left quadrant, and cone-beam computed tomography (CBCT) images identified a mesiodens located palatal to the maxillary incisors (Fig. 1; Tables I). In addition, mandibular yawing to the left created a mild asymmetry and a molar scissor-bite was noted and related to severe buccal tipping of the maxillary right second molar and severe lingual tipping of the mandibular molars (Fig. 2).

**Treatment objectives**

The treatment objectives were to: (1) relieve the crowding, (2) establish a Class I molar relationship, (3) correct the dental midline deviation, (4) obtain a stable occlusal relationship, (5) maintain gingival health, and (6) improve the smile aesthetics.

**Treatment alternatives**

The first considered option was to extract the maxillary right first premolar and the maxillary left and mandibular second premolars to relieve the crowding and correct the dental midlines. A second option was to extract four premolars and, using TSADs, close the extraction spaces to align the dentition while preventing changes to the patient’s facial profile. A third option was non-extraction camouflage treatment, involving the distalisation and uprighting of the maxillary and mandibular posterior teeth using TSADs, coupled with expansion of the dental arch, proclination of the mandibular incisors, and interproximal reduction of the anterior teeth. The patient wished to minimise her facial profile change and refused the extraction of premolars, and so the third option was chosen.

**Treatment progress**

Before the initiation of orthodontic treatment, the three third molars and the mesiodens were extracted. A palatal TSAD (three-dimensional key plate;
3DKP, Anyang, Korea) along with three miniscrews (2.0 × 10.0 mm; 3DKP, Anyang, Korea) were placed in the midpalate to assist distalisation of the maxillary posterior teeth. A wavy stainless steel palatal wire (1.2 mm in diameter) incorporating distal arms was soldered to the maxillary first molar bands. Elastomeric forces were applied from the wave part of the palatal wire to the lever arms of the 3DKP to facilitate distalisation of the maxillary posterior teeth. Elastomeric forces were also applied from the attachments on the buccal sides of both maxillary second molars to the distal arms of the palatal wire to correct the buccal tipping of the maxillary second molars. Standard edgewise appliances incorporating 0.022 × 0.028-inch slots were placed in the mandibular arch, and levelling was achieved using a 0.014-inch nickel-titanium arch wire (Fig. 3A). After two months of treatment, two miniscrews (1.6 × 10 mm; Jeil Medical, Seoul, Korea) were inserted in the mandibular buccal shelf between the mandibular first and second molars, and elastomeric forces were applied from lingual buttons on the mandibular molars to the miniscrews to address the posterior scissor-bite by buccal uprighting and intrusion of the molars (Fig. 3B).

To minimise the change in the vertical position and inclination of the maxillary incisors, brackets were not attached until sufficient space had been created for the alignment of the maxillary anterior teeth. After four months of treatment, 0.022 × 0.028-inch standard edgewise appliances were placed on the maxillary posterior teeth, and at eleven months, full fixed orthodontic treatment was started, to manage the asymmetric arch form. Approximately 2 mm of interproximal reduction (IPR) was performed on the incisors to create space for alignment and to reduce their proclination. At sixteen months, the maxillary right canine was aligned and levelled (Fig. 3C) and the finishing stage commenced to extend the total treatment time to 24 months. The fixed appliances were removed and bonded wire retainers plus circumferential retainers were provided for both arches.

**Treatment results**

Post-treatment facial photographs showed a significant improvement in smile aesthetics. Intraoral photographs, dental casts and radiographs revealed an adequate Class I dental relationship, good occlusal...
interdigitation, dental midline correction and a well-aligned dentition (Fig. 4).

Good root parallelism was noted on a post-treatment panoramic radiograph, while the lateral cephalogram and CBCT images revealed the satisfactory distalisation of the maxillary right and left first molars (2.0 mm and 3.5 mm), respectively. Both of the mandibular first molars were distalised 1.5 mm and uprighted buccolingually. The mandibular incisors were proclined by 9.5° leading to mild lip protrusion.
and an increase in arch perimeter (Figs. 4, 5, 6, Table II). A slight posterior re-positioning of the mandible and condyle occurred.

CBCT axial images showed that space remained adequate for the distalisation of the posterior teeth in the maxillary tuberosity area but there was a lack of space in the mandibular retromolar area. As a result after distalisation, the distal roots of the mandibular second molars had penetrated the mandibular lingual cortical plate (Fig. 7). Twelve-month post-treatment records revealed no significant relapse, periodontal problems, nor TMJ symptoms (Fig. 8).

Figure 5. Superimposition of the lateral cephalograms at pre-treatment (black), post-treatment (red), 1 year post-treatment (green).

Figure 6. Superimposition. Cone-beam computed tomography (CBCT) images at pre-treatment (red) and post-treatment (green): (A) Sagittal and coronal views of the right side (a, first molars; b, second molars); (B) Sagittal and coronal views of the left side (c, first molars; b, second molars). Dental casts at pre-treatment (yellow) and post-treatment (blue): (C) Maxilla; (D) Mandible.
Table II. Dental arch width changes (mm).

<table>
<thead>
<tr>
<th></th>
<th>Pretreatment</th>
<th>Posttreatment</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercanine width</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td>36.5</td>
<td>34.8</td>
<td>-1.7</td>
</tr>
<tr>
<td>Mandible</td>
<td>23.5</td>
<td>26.8</td>
<td>+3.3</td>
</tr>
<tr>
<td>Interpremolar width</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(at first premolar)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td>39.0</td>
<td>42.3</td>
<td>+3.3</td>
</tr>
<tr>
<td>Mandible</td>
<td>30.7</td>
<td>35.4</td>
<td>+4.7</td>
</tr>
<tr>
<td>Intermolar width</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(at first molar)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td>44.4</td>
<td>45.7</td>
<td>+1.3</td>
</tr>
<tr>
<td>Mandible</td>
<td>39.0</td>
<td>46.7</td>
<td>+7.7</td>
</tr>
</tbody>
</table>

Discussion

To obtain acceptable treatment results in borderline non-extraction patients, appropriate mechanics leading to distalisation of the posterior teeth, labioversion of the anterior teeth, IPR, and arch expansion should be individually and selectively planned to create the necessary alignment space.\(^4,5\)

To address a TSALD of 8.5 mm and a dental midline deviation to the right in the maxilla, the left side was distalised by 3.5 mm and the right side by 2.0 mm using a 3DKP,\(^15\) which therefore increased the arch perimeter.\(^20,21\) Space creation was assisted by about 2.0 mm of IPR\(^22\) (Fig. 6, Table II). 3DKP\(^15\) is a palatal TSAD used with a waveform transpalatal archwire to assist the 3-dimensional movement of the maxillary posterior teeth by the application of elastomeric chains (Fig. 9A–C). A waveform wire of 1.2 mm incorporating distal arms was placed to facilitate the distalisation of the maxillary posterior teeth and correct the molar scissor-bite (Fig. 9A). The maxillary posterior teeth were distalised in a bodily fashion by the applied biomechanics (Fig. 9D) rather than by intrusion mechanics (Fig. 9E).\(^15\) Additionally, Bechtold et al.\(^23\) suggested that maxillary molar distalisation using skeletal anchorage was highly stable. The maxillary space was sufficient to distalise the posterior teeth,\(^24–26\) but the distalisation of the mandibular posterior teeth was limited.

Therefore, the mandibular posterior teeth were only distalised by 1.0 mm using TSADs due to the lingual anatomical limitation of the alveolar cortical plate at root level, which was less than at crown level (Fig. 6, 7).\(^24–26\) The TSADs placed in the mandibular buccal shelf were also used to upright and intrude the lingually-inclined mandibular molars to correct the

Figure 7. Posterior available space: (A) Pre-treatment of the maxilla [presence of the maxillary right third molar]; (B) Post-treatment of the maxilla; (C) Pre-treatment of the mandible; (D) Post-treatment of the mandible.
molar scissor-bite and therefore minimise the extrusion of the molars during buccal uprighting and limit rotation of the mandible. The mandible and condyle showed a slight posterior re-positioning due to mild molar extrusion during the correction of the scissor-bite and the establishment of the posterior occlusion, but the patient showed no further TMJ symptoms.

To address the 8.0 mm TSALD in the mandible, proclination and IPR of the mandibular incisors and expansion of the mandibular arch were
performed.\textsuperscript{4,5,20–22} Tweed\textsuperscript{28} suggested that arch length will increase by 0.8 mm when the mandibular incisors are proclined by one degree. In the presented patient, the mandibular incisors were proclined by almost 10°, which increased the arch length by 8.0 mm. Caution should be exercised because these measurements are not predictable by sagittal calculation because the tooth movement occurs in three-dimensions. Therefore, a digital set-up model is recommended to ensure predictable results (Fig. 10). Unfortunately,
there are possible anatomical or biological limitations such as bone dehiscence or gingival recession that cannot be predicted during a digital model set-up until further advances in technology occur. The sagittal position of the mandibular incisors is considered to be an essential determinant of facial aesthetics and stability. Tweed advocated placing the mandibular incisors in an upright position over the basal bone to achieve optimum results. McLaughlin et al. also stated that the mandibular incisors should be positioned about 90° to 95° to the mandibular plane, and dental compensation should be limited to less than 5°, but can be extended up to 10° in particular cases. Maintaining the original position of the incisors may prevent relapse, but the presented patient required proclination of the mandibular incisors to generate the necessary arch length without the extraction of premolars.

The proclination of the mandibular incisors can result in relapse, bone dehiscence and gingival recession due to root movement through the labial alveolar bone. Fortunately, the presented patient showed no relapse nor periodontal problems because of the thick gingival biotype, and root movement did not exceed the anatomic alveolar limits (Fig. 11). These factors are worthy of consideration to reduce the effects of planned labioversion of the mandibular incisors. Since the incisors were minimally protruded to assist alignment of the dentition, the patient showed mild lip protrusion after treatment. After one year of retention, the lip protrusion had reduced, especially in the lower lip to E-line relationship. While these results are supported by previous studies, long-term observation is expected.

Conclusions
A skeletal Class II adult patient presenting with moderate crowding and a bilateral molar scissor-bite was successfully treated using extra-alveolar TSADs. This borderline case was managed by non-extraction distalisation and buccolingual uprighting of the posterior teeth accompanied by proclination of the mandibular incisors. A satisfactory occlusal relationship was achieved along with an acceptable facial profile.

Conflict of interest
The authors declare that there is no conflict of interest.

Corresponding author
Jong-Moon Chae
Department of Orthodontics, School of Dentistry
Wonkwang University, Daejeon Dental Hospital
77 Doonsan-ro, Seo-Gu
Daejeon, 35233, Korea
Email: jongmoon@wku.ac.kr

Acknowledgment
This paper was supported by Wonkwang University in 2022.

References


