Correction of a Class III malocclusion with over 20 mm of space to close in the maxilla by using miniscrews for extra anchorage

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Unilateral closure of maxillary extraction spaces in patients with Class III malocclusion can be challenging. This case report describes the closure of first premolar and first molar extraction spaces in a patient with a Class III dental relationship. Two miniscrews were used for intraoral skeletal anchorage. The Class III dental relationship was corrected; a positive vertical overbite was achieved; occlusion of the canines, premolars, and molars was improved; and the extraction spaces were closed. (Am J Orthod Dentofacial Orthop 2008; 133:459-69)

Unilateral closure of a large maxillary extraction space in a patient with a Class III dental relationship can be a serious orthodontic challenge. The use of miniscrews for skeletal anchorage during orthodontic treatment, originally introduced by Creekmore and Eklund, allows large extraction spaces to be closed during treatment, without detriment to the position of the anterior teeth.

DIAGNOSIS AND ETIOLOGY

The patient, a boy aged 13 years 6 months, was referred by his dentist for correction of his malocclusion (Figs 1-4). Clinical evaluation indicated a skeletal Class I pattern and a midline shift of the mandible by 3 mm to the right. Overbite and overjet were approximately –1 mm, and the right canine was out of occlusion; the occlusion of the right canines and the first molar was a Class III relationship. There was no crowding in either dental arch.

The facial photographs show a mild Class III facial appearance, a chin deviation of 3 mm to the right, and incompetent lips at rest. The patient reported no history of mandibular prominence in the family. Intraoral photographs and dental casts showed the extent of the 2 extraction spaces in the maxillary arch. The panoramic radiograph showed all teeth present, but there was extensive caries in the maxillary left first premolar and first molar. The patient’s general practitioner thought that both teeth were beyond repair and should be extracted. The resulting large extraction spaces would need to be restored with implants or bridges, or closed orthodontically.

The cephalometric tracing and analysis (Fig 4, Table I) showed an SNA angle of 77.6°, indicating a retrognathic maxillary complex. The ANB angle, however, was normal at 3°. The maxillary incisors were retroclined, and the mandibular incisors were slightly proclined. The Wits appraisal indicated a normal Class I relationship.

TREATMENT OBJECTIVES

The treatment objectives for this patient were to correct the Class III incisor relationship; achieve a positive vertical overbite; improve the occlusion of the canines, premolars, and molars; close the extraction spaces; finish; and retain.

TREATMENT ALTERNATIVES

Correction of the malocclusion would involve traditional orthodontic treatment with fixed appliances in both arches. A combined orthodontic/orthognathic approach after growth was initially considered. The patient had a mild skeletal Class III relationship, but cephalometric measurements were within the normal range, and no prominent jaws were reported in the family. Development of a more severe Class III skeletal relationship was thought unlikely; therefore, delaying the start of treatment to observe the need for surgical correction of the skeletal relation was not indicated.

Closure of extraction spaces closure was the most challenging aspect, particularly because of the Class III incisor relationship. Correction of the occlusion without closing the spaces was, of course, an option, but this treatment plan would require prosthetic restoration of the
dentition after orthodontic treatment. Because of the patient’s age, alveolar growth after orthodontic treatment would be expected; temporary prosthetic devices would be needed to fill the spaces in the maxillary arch until dental implants could be used for a definitive solution.

If feasible, closure of 1 extraction space or both would be the treatment of choice.

**TREATMENT PLAN**

Orthodontic mechanics with significantly reduced friction in the molar and premolar regions were desirable because less friction would help reduce the force needed to close the extraction spaces. Molar and premolar tubes were used (Fig 5).

Two miniscrews (1 between the maxillary left lateral incisor and the canine; the second just distal to the canine) were placed to significantly enhance anterior anchorage during protraction of the maxillary left second premolar and the second molar. Interarch elastic traction would be used to help with correction of overjet, overbite, and occlusion.

**TREATMENT PROGRESS**

The maxillary teeth were bonded with a .022-in preadjusted self-ligating bracket system. In the maxillary incisors and canines, interactive self-ligating brackets were used. In the maxillary premolars and molars, bonded tubes were placed. Tip and torque values used in this patient are listed in Table II.

A continuous .014-in nickel-titanium-selenium wire, with a dimple between the maxillary central incisors to prevent sliding, was used during the first phase of treatment.

After leveling, which took only 8 weeks, a .016 × .025-in nickel-titanium-selenium wire was used for further correction of rotations, tip, and torque of the maxillary teeth. One month later, a panoramic radiograph was taken to help determine the position of the miniscrews (Fig 6).

Miniscrews (diameter, 1.6 mm; length, 10 mm) were considered ideal for this patient, and he was referred to the maxillofacial surgeon for placement of 2 miniscrews under local anesthesia. One was placed between the maxillary left lateral incisor and the canine, and the second just distal to the canine.

Immediately after surgery, a ligature was used to connect the miniscrew to the maxillary left canine to increase the anchorage value of this tooth (Fig 7). A nickel-titanium spring was then used to provide gentle forces to protract the second premolar and the second molar simultaneously. Those teeth had been previously linked together with a steel ligature. At the next visit, even

![Fig 1. Pretreatment extraoral and intraoral photographs.](image)
with the miniscrew to stabilize the position of the canine, some distalization was observed (Fig 8). Because of this loss of anchorage, the mechanical system was changed. Direct loading of the mesial miniscrew with the same nickel-titanium spring might have helped to protract the second premolar and the second molar, but without the reciprocal distalizing force on the canine.

Fig 2. Pretreatment dental casts.

Fig 3. Pretreatment panoramic radiograph.

Fig 4. Pretreatment cephalometric tracing.
As a result of the direction of the applied traction, an open bite started to develop (Fig 9). It was decided at this stage to use a sliding hook with a long arm placed distal to the second premolar to provide the force to protract it. For protraction of the second molar, a nickel-titanium spring connected to the distal miniscrew and the second molar was used.

For evaluation purposes, a panoramic radiograph was taken (Fig 10). Controlled protraction of the second premolar and the second molar (without tipping of the roots) was confirmed. Extraoral photographs were used to evaluate facial changes (Fig 11). Fixed appliances were placed in the mandible to correct the sagittal and vertical relationships between the arches. Protraction of the second premolar and the second molar was finally hindered by the position of the miniscrews, and they were removed, without anesthetic, during a regular appliance check visit. No pain or discomfort was reported, either during or after removal. Once the miniscrews had been removed, final correction of the malocclusion occlusion was achieved with the help of interarch elastics.

At the end of treatment, the maxillary dental midline was positioned in line with the facial midline, but the mandibular dental midline was not coordinated with the maxillary midline, because of the underlying mandibular asymmetry.

The panoramic radiograph (Fig 12) shows good position of the roots with no root resorption evident. The maxillary left third molar should erupt in occlusion with the mandibular second molar. The second mandibular molar overerupted slightly during the first few weeks after treatment; the overeruption was identified at the first posttreatment check visit, and a fixed retainer was used to prevent further eruption (Fig 13).

The posttreatment cephalometric tracing and cephalometric values are shown in Figure 14 and Table I. Superimposed tracings (Fig 15) show the differences in the position of the maxillary left second molar before treatment. The maxillary superimposition shows the position of the left second molar and the most prominent maxillary incisor, and the mandibular superimposition shows the position of the first molar and most

<table>
<thead>
<tr>
<th>Pretreatment</th>
<th>Posttreatment</th>
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<tbody>
<tr>
<td>SNA angle</td>
<td>77.6°</td>
</tr>
<tr>
<td>SNB angle</td>
<td>74.5°</td>
</tr>
<tr>
<td>ANB angle</td>
<td>3.0°</td>
</tr>
<tr>
<td>Y-axis</td>
<td>70.2°</td>
</tr>
<tr>
<td>U1 to ANS-PNS</td>
<td>98.6°</td>
</tr>
<tr>
<td>SOB</td>
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</tr>
<tr>
<td>VOB</td>
<td>−1.0 mm</td>
</tr>
<tr>
<td>U1 to FOP</td>
<td>−0.4 mm</td>
</tr>
<tr>
<td>L1 to FOP</td>
<td>−0.6 mm</td>
</tr>
<tr>
<td>LI to MP</td>
<td>97.3°</td>
</tr>
<tr>
<td>SN to MP</td>
<td>35.6°</td>
</tr>
<tr>
<td>Wits appraisal</td>
<td>0.1 mm</td>
</tr>
</tbody>
</table>

SOB, overjet; VOB, overbite; FOP, functional occlusal plane.

![Fig 5. Brackets and tubes (Hero system) used in this patient.](image)

![Table II. Torque, angulation, and tip values](image)

<table>
<thead>
<tr>
<th>Maxilla</th>
<th>Torque</th>
<th>Angulation</th>
<th>Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central incisors</td>
<td>+12°</td>
<td>+5°</td>
<td></td>
</tr>
<tr>
<td>Lateral incisors</td>
<td>+8°</td>
<td>+9°</td>
<td></td>
</tr>
<tr>
<td>Canine with hooks</td>
<td>−2°</td>
<td>+9°</td>
<td></td>
</tr>
<tr>
<td>First and second premolar tubes (+ hooks)</td>
<td>−7°</td>
<td>+0°</td>
<td></td>
</tr>
<tr>
<td>First and second molar tubes (+ hooks)</td>
<td>−10°</td>
<td>+0°</td>
<td>10°</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mandible</th>
<th>Torque</th>
<th>Angulation</th>
<th>Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior teeth</td>
<td>−1°</td>
<td>0°</td>
<td></td>
</tr>
<tr>
<td>Canines with hooks</td>
<td>−2°</td>
<td>+7°</td>
<td></td>
</tr>
<tr>
<td>First premolar</td>
<td>−11°</td>
<td>0°</td>
<td></td>
</tr>
<tr>
<td>Second premolar tubes with hook</td>
<td>−17°</td>
<td>0°</td>
<td></td>
</tr>
<tr>
<td>First molar tubes with hooks</td>
<td>−20°</td>
<td>0°</td>
<td></td>
</tr>
<tr>
<td>Second molar tubes with hooks</td>
<td>−20°</td>
<td>0°</td>
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</tr>
</tbody>
</table>

![Fig 6. Panoramic radiograph during treatment.](image)
prominent incisor. Posttreatment extraoral and intraoral photos were taken during the first retention visit, 8 weeks after removal of the appliance (Fig 16). Retention consisted of a fixed retainer in the mandibular arch and an Essix (Raintree, Seoul, Korea) retainer in the maxillary arch (Fig 17). During settling, the occlusion changed. Plaster study models taken 6 months post-treatment (Fig 18) show coordinated midlines.

The total active treatment time was 1 year 6 months.
DISCUSSION

The main problem in treating this patient was the excessive extraction spaces in 1 side of the maxillary arch with no crowding and no overjet. Closing this extraction space, without a detrimental effect on the maxillary arch form, and correcting the interarch relationships were extremely tall orders.

The etiology of this malocclusion was mainly genetic, with a small retropositioned maxilla. Treatment was complicated by the extreme dental decay.

The patient needed medication early in his life for severe asthma; this might have contributed to the decay, but the medical history was not clear. He was not a regular dental patient. Before any orthodontic treatment was attempted, dietary habits and oral hygiene were discussed with him and his parents. During active treatment, the patient was asked to use a fluoride rinse daily to prevent further tooth decay.

Anchorage

At least a quarter of the extraction space is routinely occupied by the anchor teeth during orthodontic treatment unless measures are taken to supplement this anchorage.\textsuperscript{2} Absolute anchorage was needed to prevent retraction of the maxillary incisors and worsening of the Class III incisor relationship. Ideally, the maxillary incisors would be moved forward during orthodontic treatment to correct overjet and overbite.

Anchorage loss is related to the forces needed to protract the premolar and the second molar. If a bracket system with lower friction is used, less force will theoretically be needed to protract the teeth, and therefore less anchorage loss can be expected.\textsuperscript{3}

Self-ligating brackets were introduced in the mid-1930s in the form of the Russell attachment (United States Patent 6302688). Two types of self-ligating brackets are popular: those with a self-ligating clip that does not press against the wire (passive), such as the Damon and Smart Clip brackets, and those with a clip that presses against the wire if a larger wire is used (interactive), such as Speed, System R, and Time brackets.

In this patient, a combination of passive and interactive brackets was used. A combination of rectangular wire and interactive brackets (Time; American Orthodontics, Sheboygan, Wis) was used to correct the torque of the incisors, overjet, and overbite. Passive brackets (Nr 098-1510C, Nr 098-1511C; Hero tubes) were used to protract the premolar and the molar in the maxillary arch. Elastic forces were also used to counteract tongue and lip pressure and close the bite.
Several studies demonstrated significant decreases in friction for self-ligating brackets, compared with conventional bracket designs, by using elastics or steel ligatures.4-7

The use of premolar and molar tubes in this patient contributed to a mechanical system that required low forces to move the teeth. When temporary anchorage devices are used, a low force system is recommended.8,9

It has been suggested that reduced friction can help to shorten treatment time, especially in extraction patients in whom tooth translation is achieved by sliding mechanics.

**Anchorage alternatives**

Extraction of the right first premolars in the maxilla and the mandible was also considered, but, because of the patient’s Class III profile, cephalometric values, dental relationships, and the absence of crowding in the arches, this treatment alternative was rejected. Closing of all spaces in the left side of the maxilla during correction of the occlusion, without compensating extractions, required additional anchorage. A facemask to provide this extra anchorage was considered, but, because of the patient’s age, sufficient compliance in using it during treatment could not be guaranteed, and he was not keen about this approach. Furthermore, anchorage was needed only on the left side of the maxilla, so it was a unilateral problem.

The use of a standard dental implant in the first premolar region for temporary anchorage during orthodontic tooth movement to protract the maxillary left second molar, and then as a permanent abutment for tooth replacement, was reported and was considered.10-15

The patient’s age would have necessitated additional time for osseointegration, and this, in addition to the costs of the implant and the crown, meant that this approach was rejected.

Several temporary anchorage devices for orthodontic anchorage have been introduced.16-18 In this patient, several temporary anchorage devices could have been used. A palatal implant was described for absolute anchorage during orthodontic treatment and can be used for various orthodontic procedures such as en-masse retraction of the 6 anterior teeth or canine distalization without anchorage loss.19-21 The position of a palatal implant is not the most suitable place for skeletal anchorage to protract a second premolar and molar, and this treatment option was rejected in this patient. There were other disadvantages to a palatal implant for this patient, such as the extra time needed for its integration, the costs of the implant, and the discomfort of surgical placement and removal.

Miniplates can be used to help protract the denti-

![Fig 15. Superimposed tracing before and after treatment. Maxillary superimposition shows the position of the maxillary left second molar and the mandibular incisors, before and after treatment.](image-url)
tion.22-27 Because titanium miniplates have been thoroughly evaluated as a biocompatible material and used for surgical procedures, they can also be used for improving orthodontic anchorage.

However, the implant side must have sufficient cortical bone. In the maxillary region around the incisors, cortical bone depth is often lacking.

Another disadvantage of miniplates for anchorage is the more complicated surgical procedure, including a gingival flap during fixation and removal of the device.

Miniscrews can be used for additional anchorage during fixed appliance treatment.27-30 In this patient, the placement of 2 miniscrews (Jeil Medical, Seoul,
Korea) was considered the most suitable treatment option. The surgical procedure required only local anesthetic, no gingival flap was required, miniscrews are relatively inexpensive, and miniscrews can be removed in the orthodontic office without anesthesia.

**Surgical procedure**

When orthodontic treatment including miniscrews is planned, a protocol for their use should be followed, but there is no widely accepted protocol yet.31-38

Our team’s procedure for placing miniscrews usually uses these guidelines. The patient rinses with a chlorhexide solution for at least 1 minute before surgery. Local anesthetics are administered, and self-tapping screws are used without predrilling, unless the cortical bone is excessively thick. In that case, predrilling of the cortical bone only is sufficient. Manual screwdrivers are always used, and the junction of the attached gingiva and the reflected mucosa is considered to be the ideal site. The miniscrew is placed at an angle of up to 45° to the cortical plate. Primary stability, indicated by the screw’s resistance to lateral movement, is desirable. If primary stability is not achieved, a larger screw, a different location, or an additional screw should be considered. After surgery, the patient is instructed on the maintenance of the miniscrews and referred to the orthodontist for the application of orthodontic force. Immediate loading with a gentle force from a nickel-titanium spring (within several hours of surgery) is recommended.

In our opinion, the orthodontist is responsible for postoperative instruction on screw cleaning and what the patient should do in case of screw failure.

Relatively low forces should be used, and therefore sliding mechanics and bracket systems with low friction are recommended. Intermittent forces should certainly be avoided. Continuous forces (nickel-titanium springs, nickel-titanium wires, power chain, E-links) can all be used effectively.

**Treatment after the surgical procedure**

A nickel-titanium coil spring (with a constant force of 100 g) was used to protract the second premolar and the second molar. In this patient, the initial treatment mechanics and the strengthening of the anchorage of the maxillary left canine were not outstandingly successful. Changing the force mechanism to direct loading of the miniscrew was successful. Changing the force mechanism again was also needed to correct the open bite caused by the vertical component of traction.
The use of 2 miniscrews placed bucally in the inter-radicular bone necessitated removal of the screws after space closure. The miniscrew at some point in treatment causes an obstruction to complete the space closure and should then be removed. These miniscrews will be os-seointegrated, but, because their surface is polished, they can be easily removed without anesthesia.39-40

Retention

Retention after orthodontic treatment is almost invariably needed. In this patient, a fixed retainer in the mandible was used for permanent retention.

In the maxillary arch, there can be a tendency for spaces to reopen if the treatment result is not retained. A wraparound retainer was used in this patient. After the eruption of the maxillary left third molar, daily use of the retainer might be no longer be necessary to prevent reopening of the extraction spaces, and alternative retention can than be considered. The correction of the dental midlines, as observed 6 months after treatment during the clinical posttreatment evaluation, was remarkable.

The author thanks Jonathan Sandler for his help with the text.

REFERENCES