Total distalization of the maxillary arch in a patient with skeletal Class II malocclusion

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In nongrowing patients with skeletal Class II malocclusion, premolar extraction or maxillary molar distalization can be used as camouflage treatment. Orthodontic miniscrew implants are widely used for this purpose because they do not produce undesirable reciprocal effects and do not depend on the patient’s cooperation. This article reports on maxillary molar distalization by using miniscrew implants to correct a Class II problem. The main considerations of molar distalization treatment with miniscrew implants are discussed. (Am J Orthod Dentofacial Orthop 2011;139:823-33)

The treatment options for nongrowing skeletal Class II patients include camouflage treatment and surgical correction. In a skeletal Class II patient having a short vertical dimension with no transverse discrepancies, it has been reported that an increase in the vertical dimension by orthognathic surgery or molar extrusion is unstable after a long-term follow up.1-3 Therefore, if there is minimal skeletal discrepancy, a camouflage approach maintaining the vertical dimension after extraction would be an appropriate treatment alternative for stable treatment results.

In camouflage treatment, the premolars are extracted to relieve crowding, correct protrusion, and establish proper occlusion. Creating space by stripping and correction of the Class II molar relationship with maxillary molar distalization would be an alternative treatment. Distalization of maxillary molars can be accomplished by using a pendulum appliance, a distal jet, or a headgear.4-6 Recently, miniscrew implants and miniplates have become widely used to treat Class II problems.7-12

In this case report, miniscrew implants were used to distalize the maxillary molars, relieve the crowding, and establish a Class I molar relationship.

DIAGNOSIS AND ETIOLOGY

The patient was a 21-year old man with a chief complaint of dental crowding. The pretreatment facial photographs showed protrusion of both upper and lower lips, a deep mentolabial fold, and mandibular asymmetry around the chin area. This was the result of trauma when he was 6 years old (Figs 1 and 2). In the frontal cephalogram, the chin was deviated to the left side, and an asymmetric mandibular lower border was observed. The lateral cephalometric analysis showed a Class II skeletal pattern with a low mandibular plane angle (Fig 3, Table). The IMPA angle of 117.5° reflected a compensatory proclination of the mandibular incisors, although it was measured from the most labially positioned tooth, which was the left central incisor. The upper and lower lips were protrusive by 4.1 and 8.0 mm, respectively, from the esthetic line. The panoramic radiograph showed that both maxillary third molars were fully erupted, and the periodontal state was generally good. Molar relationships were Class II on both sides. The maxillary midline was 3.0 mm to the right of the facial midline, because of the ectopic right canine. The mandibular midline was 1.5 mm to the left of the facial midline with moderate anterior crowding. Overbite was 3.0 mm, and overjet was 2.5 mm. The Bolton tooth-ratio analysis (sum of incisors, 4:3.08; anterior ratio, 80.4%; overall ratio, 92.9%) indicated that the mandibular teeth were generally larger than the maxillary teeth.

Based on these findings, the patient was diagnosed as skeletal Class II Division 1 with a hypodivergent profile and facial asymmetry.
TREATMENT OBJECTIVES

The treatment objectives for this patient were to (1) relieve the crowding, which was his chief complaint; (2) correct the skeletal Class II facial asymmetry and hypodivergent profile; (3) establish Class I molar and canine relationships; (4) correct the midline shift; (5) create ideal overbite and overjet; and (6) ultimately establish a proper soft-tissue profile.

TREATMENT ALTERNATIVES

For the correction of the skeletal discrepancy and facial asymmetry, an orthognathic surgical treatment with extraction of the mandibular first premolars was initially discussed. A nonsurgical approach with extraction of the maxillary first premolars and the mandibular second premolars followed by genioplasty to improve his facial profile was also presented as an alternative. However, he refused all surgical treatments including premolar extraction and wanted only the crowding to be resolved. He was not interested in improving his occlusion and facial profile, and correcting the dental midline through orthodontic treatment.

Therefore, the treatment objectives for this patient were redirected to relieve crowding and maintain the sagittal position of the maxillary anterior teeth to prevent further protrusion of the upper and lower lips. With respect to the patient’s request, treatment alternatives excluding premolar extraction and orthognathic surgery were discussed.

The treatment plan involved molar distalization by orthodontic miniscrew implants after extraction of the third molars. This was because the treatment goal was to maintain the maxillary incisor position despite the severe maxillary arch-length discrepancy. Also, lateral expansion of the maxillary arch needed to be prevented.
**Fig 2.** Pretreatment dental casts.

**Fig 3.** Pretreatment lateral and frontal cephalograms and panoramic radiograph.
because of unfavorable long-term stability issues and a possible adverse periodontal response. In the mandible, the treatment included intrusion of the anterior teeth to flatten the deep curve of Spee. Protraction of the left mandibular quadrant with a miniscrew implant to correct the midline deviation and establish proper incisor and molar relationships was planned as well.

In the maxillary arch, the planned amounts of distalization were 4.0 mm on the right side and 3.0 mm on the left. By moving the maxillary dentition superiorly and posteriorly, the occlusal plane angle would be maintained, and the vertical dimension would not be increased. In the mandibular arch, the incisors were to be intruded 2.0 mm, and the mandibular left quadrant was to be protracted by 1.5 mm. Because of tooth-size discrepancies, additional spaces of 0.5 mm in the maxilla and 2.5 mm in the mandible would be created by interproximal stripping.

**TREATMENT PROGRESS**

Before the orthodontic treatment, the maxillary third molars were extracted to distalize the maxillary dentition, and the mandibular third molars were also extracted because of partial impaction. To maintain the sagittal position of the maxillary anterior teeth, the second molars were distalized first by using a modified pendulum appliance before leveling and alignment with bracket bonding (Fig 4). For molar distalization, a miniscrew implant (Orlus, Ortholution, Seoul, Korea) was placed in the midpalate, which is known to be the most stable and useful position in the maxilla. Five months later, interproximal spaces of 2 mm on the right side and 4 mm on the left were obtained between the first and second molars. To distalize the other teeth and relieve crowding simultaneously, 0.022 × 0.028-in edgewise brackets were bonded to both arches, and 2 miniscrew implants were placed in the buccal interradicular bone. The modified pendulum appliance was removed. In the maxilla, a 0.016 × 0.022-in nickel-titanium wire was engaged, and 200 g of distal driving force was applied with an elastomeric chain, which was intended to make space for a lingually positioned lateral incisor on the right side and to correct the midline and molar relationship on the left. In the mandible, the anterior teeth were intruded and proclined labially, and, during this period, interproximal stripping was performed several times.

Eight months after bracket bonding, leveling and alignment in the maxilla were almost complete. At this time, the molar and canine relationships were Class I on the right side and Class II on the left (Fig 5). The maxillary dental midline was shifted 1.5 mm to the right of the facial midline, and the mandibular midline was shifted 1.5 mm to the left. Distalization of the maxillary left quadrant was continued, and a miniscrew implant was placed between the mandibular left first and second premolars to protract the left quadrant.

Torque control and leveling of the maxillary right lateral incisor and canine were accomplished by using 0.016 × 0.022-in nickel-titanium and 0.017 × 0.025-in beta-titanium alloy wires. Two crimpable hooks were attached between the lateral incisor and the canine, and the canine and the first premolar, on each side of the maxillary wire. Distal driving forces of 200 g were applied to the left side and 100 g to the right to hold the position, while the left segment was distalized. A protraction force was applied to the mandibular left first molar with an elastomeric chain, which passed from

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Fig 4. Intraoral photograph 5 months after the start of treatment. A modified pendulum appliance was used to move the maxillary molars distally.
the miniscrew to a long crimpable hook attached to the wire that was distal to the tube on the tooth.

After 25 months of treatment, the molar relationships on both sides were Class I, and the midline deviation was corrected (Fig 6). The anteroposterior movement of the teeth was completed. The finishing stage, which took 5 months with box elastics to seat the occlusion, was achieved with 0.016 × 0.022-in and 0.016-in stainless steel wires in the maxilla and 0.018-in and 0.016-in stainless steel wires in the mandible.

The appliances were removed after 30 months of active treatment (Figs 7-10). The miniscrew implants were removed before the orthodontic treatment had been completed. Fixed lingual retainers were bonded to the lingual surfaces of both arches. A maxillary circumferential retainer was delivered with instructions to wear it for 24 hours each day for the first 6 months and at night only thereafter for 18 months.

TREATMENT RESULTS

Crowding, which was the patient’s chief complaint, was eliminated. The midline deviation was corrected, and the dental midlines were aligned with the facial midline. The posterior occlusal relationships were improved to achieve Class I canine and molar relationships on both sides. The deep curve of Spee in the mandibular arch was reduced with flaring of the anterior teeth. More ideal overbite and overjet relationships were established.

The cephalometric analysis and superimposition showed no skeletal change, as expected in the camouflage treatment of an adult patient (Fig 11, Table). The maxillary incisor was intruded 1.0 mm and retracted 3.0 mm in a bodily manner from the initial position. In the mandible, the malpositioned left central incisor was moved 1.5 mm lingually, and the other anterior teeth were moved 1.5 mm labially. The maxillary molars were distalized 4.5 mm on the right and 3.5 mm on the left; the mandibular dentition on the left side was protracted 1.5 mm. Facial esthetics were improved with decreased upper and lower lip protrusion.

In the maxilla, the intercanine width appeared to be decreased by 0.2 mm, but it was actually increased because the maxillary right high canine had been aligned. The intermolar width was also increased by 2.3 mm, and the increase appeared to contribute to the reduction in crowding and the retraction of the anterior teeth. The mandibular intercanine width was increased by 2.7 mm, and the inter premolar and intermolar widths showed no noticeable changes.

The treatment results were maintained after 3 years of retention (Figs 12 and 13, Table). Mesial movements of the incisors and molars within 0.3 mm were observed, but these did not affect the occlusion or the soft-tissue profile. The fixed lingual retainer was fractured and fell out of the maxillary right segment during the retention period, so it was remade and rebonded.
DISCUSSION

In the camouflage treatment of a skeletal Class II patient, extraction only in the maxilla or both arches is a common method to correct crowding, protrusion, and occlusal relationships. Intraoral and extraoral appliances are also commonly used to move the maxillary molars distally to correct a Class II problem. However, extraoral appliances have a limitation in that treatment success depends on the patient’s cooperation. With the pendulum and distal jet appliances, distal movement of the molars occurs with labial proclination of the anterior teeth. Orthodontic miniscrew implants have been used as absolute anchorage to prevent these complications.7-11

To treat this patient without extractions, the maxillary molars should be moved distally, which was critical for the success of treatment, and the mandibular left molars should be moved anteriorly. In distalization treatment with miniscrew implants, it is essential to consider the biological and biomechanical aspects as well as the stability.

In the biological aspect, the following should be considered: the necessary space in the maxillary tuberosity area to move the teeth distally, the limitation of camouflage treatment, and the interference of miniscrew implants placed between the adjacent roots to distalize the entire dentition.

In this patient, the maxillary third molars were extracted before orthodontic treatment to allow sufficient space in the maxillary tuberosity area to distalize the teeth. This made the teeth move within the alveolar bone where the other teeth had been. The amounts of arch expansion and labial proclination that could easily weaken the periodontal support in nonextraction camouflage treatment were minimized in terms of distalization by using miniscrew implants. After treatment, the maxillary arch was expanded 2 to 3 mm, but potential

Fig 7. Posttreatment facial photographs and intraoral photographs.
Fig 8. Posttreatment dental casts.

Fig 9. Lateral cephalogram and panoramic radiograph.

Fig 10. Frontal cephalogram 2 months before removing the appliance.
periodontal complications such as gingival recession or alveolar bone dehiscence was not observed. The inclination of the anterior teeth after treatment did not show labial flaring because of distalization and stripping. To prevent the miniscrew implants from interfering with the distalization, clearance between the miniscrew tip and the root apex should be made in the coronal view by angulating the miniscrew implants superiorly. As shown in Figure 14, the miniscrew implant that had been placed between the maxillary first premolar and the first molar was located above the second premolar after distalization of the molars.

Biomechanical considerations in the transverse, vertical, and sagittal planes are essential. In the transverse plane, the distal driving force that passes from the miniscrew implant to the archwire causes arch expansion and buccal crown torque, because of the size difference of the wire and the bracket slot. In other words, the force from the miniscrew implant can be separated into horizontal and vertical components. The vertical component is responsible for the buccal crown torque of the posterior teeth, since its line of action passes through the buccal side of the posterior teeth. Therefore, it is essential to cancel these contralateral equal and opposite couples by using a passive transpalatal arch. Perhaps some palatal crown torque can be added if a passive transpalatal arch does not provide enough moment. Even though a precision transpalatal arch with palatal crown torque and a toe-in bend on the molar area were used, buccoversion of the posterior teeth and 2 to 3 mm of expansion of the intermolar width were observed when the distalization was completed. This could be corrected at the finishing stage by intermaxillary elastics with a round stainless steel wire in the maxilla. Because the distal driving force included an intrusive force component, the intermaxillary elastics did not seem to increase the original vertical dimension.

In the vertical plane, occlusal-plane canting should be monitored carefully. The mandibular left first molar was protracted with an elastomeric chain from the bonded tube to the miniscrew implant, which was placed on the mucogingival junction between the first and second premolars. In other words, the line of protraction force was not parallel to the occlusal plane. Consequently, the mandibular occlusal plane was canted down on the left side. The line of action was adjusted to be parallel to the occlusal plane by making a long hook on the distal wire of the bonded tube of the mandibular left first molar. After the protraction was complete, the remaining canting was corrected with unilateral intermaxillary elastics.

In the sagittal plane, a backward-upward force can cause linguoversion of the maxillary anterior teeth and change the occlusal plane angle. The center of resistance of the maxilla was assumed to be near the root apex of the maxillary first premolars. Although the center of resistance of the maxillary dentition has not been reported yet, it can be estimated by the center of resistance of each tooth. The vertical position of the center of resistance for the maxillary dentition seems to be around the center of resistance of each tooth, and the sagittal position is between the first and second premolars (Fig 15, A). Therefore, the distal driving force from the miniscrew implant to the hook between the lateral incisor and the canine makes the maxillary dentition rotate clockwise. This leads to linguoversion of the anterior teeth and changes the occlusal-plane cant. Since the anterior tooth inclination was within the normal range (U1 to SN, 108.1°) and the occlusal plane angle of this patient was planned to be maintained, a 10° compensating curve was added to the archwire to counteract the moment that makes the maxillary dentition rotate clockwise (Fig 15, B). It was monitored every 6 months on lateral cephalograms.

In terms of the stability of treatment, the following should be considered: the success rate of miniscrew implants, the remodeling of the periodontium after treatment, and the stability of the arch expansion. Although miniscrew implants have a success rate of approximately 90%, there is still the possibility of loosening. The alternatives in case of loosening should be suggested before treatment. The patient was aware of the possibility of loosening and agreed with the
alternatives such as wearing headgear, additional stripping, and arch expansion.

The remodeling of the periodonium should be also considered. In molar distalization treatment, the maxillary second molar is moved into the maxillary tuberosity, where there is abundant attached gingiva. Because the vertical dimension of this patient was not to be increased, the maxillary second molars were moved upward and backward; this resulted in a 3- to 5-mm pseudopocket around the teeth, particularly on the distal surface. The gingival swelling around the maxillary second molars, which had been observed when the distalization had finished, still remained after 5 months of the finishing stage. When the appliances were removed, the pocket depth on the distal surface of the maxillary second molars was 3 to 4 mm. An end tuft brush was recommended during and after active orthodontic treatment. Additional periodontal surgery was planned in case the swelling was not resolved during the retention period. After 6 months of retention, the pocket depth on the distal surface of the maxillary second molars was 2 to 3.5 mm, and periodontal surgery was not necessary.

The stability of the arch dimension is essential. As mentioned above, the increase of arch width was unavoidable, even with a toe-in bend applied in the molar area. In the mandibular arch, enlargement should be avoided for long-term stability, but expansion of 2.7 mm in canine width was observed.19,20 After 3 years of retention, the intercanine widths of the maxilla and the mandible, and the intermolar width of the maxilla, were maintained. The differences of each measurement between posttreatment and 3 years after treatment were within 0.6 mm. Because the fixed lingual retainers seemed to contribute to the stability, long-term retention might be necessary to prevent a relapse.

Fig 12. Facial and intraoral photographs after 3 years of retention.
CONCLUSIONS

In a nongrowing skeletal Class II patient, orthodontic miniscrew implants make it possible to correct the posterior occlusion, eliminate the crowding, and correct the midline simultaneously by molar distalization without tooth extraction or the patient’s cooperation. The treatment result was maintained well after 3 years of retention. A predictable and stable treatment outcome can be achieved with orthodontic miniscrew implants by considering the biological and biomechanical aspects and the stability after treatment.

REFERENCES