Distalization of the mandibular dentition with mini-implants to correct a Class III malocclusion with a midline deviation

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This article describes the orthodontic treatment for a young woman, aged 23 years 5 months, with a Class III malocclusion and a deviated midline. Two orthodontic mini-implants (C-implants, CIMPLANT Company, Seoul, Korea) were placed in the interdental spaces between the mandibular second premolars and first molars. The treatment plan consisted of distalizing the mandibular dentition asymmetrically and creating space for en-masse retraction of the mandibular anterior teeth. C-implants were placed to provide anchorage for Class I intra-arch elastics. The head design of the C-implant minimizes gingival irritation during orthodontic treatment. Sliding jigs were applied buccally for distalization of the mandibular posterior teeth. The active treatment period was 18 months. Normal overbite and overjet were obtained, and facial balance was improved. (Am J Orthod Dentofacial Orthop 2010;137:135-46)

E very orthodontic tooth movement is accompanied by a reaction. This can make it difficult to correct a malocclusion by using intraoral appliances alone, especially when complete distal movement of the mandibular dentition is planned in nonsurgical Class III malocclusion treatment. Traditionally, fixed appliances and intermaxillary elastics have been used to move mandibular molars distally, often resulting in undesirable proclination of the maxillary incisors and extrusion of the maxillary molars as reciprocal side effects. This can cause an esthetic problem and instability, especially in long-faced adults. Also, because intermaxillary elastic wear requires patient compliance, it is difficult to predict the final result in uncooperative patients. Therefore, several authors have attempted to treat this type of malocclusion by distal tooth movement alone. For example, animal studies and clinical investigations have used conventional implants as absolute anchorage and miniplates for intrusion or distalization of the mandibular posterior teeth. Because all portions of the anchor plates and screws were placed outside the dentition in these studies, it was possible to move the mandibular molars without disturbing tooth movement.

Recently, the mechanics of group distal movement of teeth with microscrew implant anchorage was introduced. A distalizing force is applied to the canines through a nickel-titanium (NiTi) coil spring connecting the miniscrew to hooks on the archwire. The primary treatment effect in the mandible is distal tipping movement of the posterior teeth concurrent with uprighting and distal movement of the anterior teeth. Because there is no force to move the maxillary anterior teeth forward (via Class III elastics), there are no side effects on the maxillary anterior teeth in microscrew implant-aided mechanics. Therefore, distal movement assisted by a rigid orthodontic implant can be a good alternative for treatment when intermaxillary elastics are not indicated or the patient is uncooperative.

The stability of temporary skeletal anchorage devices is achieved from primary mechanical retention between the implant surface and the cortical bone, and secondary stability is provided by the healing process of the surrounding tissue. Primary stability is important to minimize the potential for failure from micromotion. Secondary stability is related to the microstructure of the implant surface. In conventional dental
prosthetic implants, implants with a rough surface showed better stability and tissue reactions than did those with a smooth surface. In orthodontic implants, porous-surfaced implants show higher marginal bone levels and less relative implant displacement than threaded implants.12,13

The C-implant (CIMPLANT Company, Seoul, Korea) was developed to use osseointegration as the main stabilizing mechanism.14-17 This mini-implant has an upper abutment head component and a lower threaded body or screw-type component (Fig 1). The unique head design makes it possible to apply multiple elastics while simultaneously preventing the elastics from slipping off.15,16 The body or retentive component of the C-implant is better able to resist the rotational tendency of heavy dynamic loads and control 3-dimensional tooth movement as a result of its higher osseointegration potential.

When distalizing the mandibular dentition with a mandibular C-implant, the most important consideration is its position. The placement site should be as close as possible to the mesial surface of the mandibular first molar because this will help achieve optimal distalization of the mandibular dentition. The initial tooth movement in distalization is posterior movement of the second molar by using a sliding jig that is connected to the main archwire, followed by moving the other teeth posteriorly (Fig 2). While the second molar is distalizing, the first molar also moves distally as a result of drifting. When molar distalization is complete, the premolars will also begin to move with the sliding jig. While the premolars are distalizing, spaces might develop between the anterior teeth. To retract the anterior teeth with en-masse retraction, closing loops are placed between the lateral incisors and canines, and connected to the C-implants by elastics. Because intermaxillary elastics are not applied to the maxillary dentition, mesial movement of the maxillary arch and extrusion of the maxillary molars are avoided, and the incisors are not flared. This case report describes the distalization of the mandibular dentition to treat a dental Class III malocclusion with a deviated midline by using C-implants.

**DIAGNOSIS**

The patient was a woman, aged 23 years 5 months, whose chief concern was protruding mandibular teeth. Her medical history was noncontributory, and occasional clicking of her temporomandibular joints (TMJ) was noted in her dental history.

The pretreatment facial photographs (Fig 3) show an acceptable facial profile, despite mild midface deficiency and slight mandibular prognathism. No facial asymmetry was noticeable in the frontal view. The clinical examination (Figs 3 and 4) showed a Class III molar and canine relationship that was more significant on the right side. Other findings included an anterior edge-to-edge relationship, a midline discrepancy, mild mandibular anterior crowding, and mesial angulation of the mandibular posterior teeth. The lower midline was not coincident with the facial midline and was shifted to the left by 2.5 mm. The maxillary third molars and the mandibular right third molar were missing.
There was only slight contact between the maxillary right second molar and the opposing tooth because of the Class III molar relationship.

The cephalometric analysis (Fig 5B; Table) showed a skeletal Class III relationship with a high mandibular plane angle and a slightly retrognathic maxilla. The anterior facial height was slightly long relative to the posterior facial height. The incisor position and interincisal relationship were within normal limits except for the retroclined maxillary incisor. The patient was diagnosed with a skeletal Class I malocclusion with mild maxillary deficiency and a dental Class III relationship.

**TREATMENT OBJECTIVES**

A mandibular premolar extraction plan would be a relatively simple and stable way to resolve the anterior crossbite. Complex treatment mechanics and many tooth movements would not be needed. However, the patient did not want extractions (except for the third molars) or changes to her facial appearance; she wanted only to correct the incisor relationship. Although the maxillary incisors were slightly upright, the patient requested that they not be allowed to move forward. Therefore, we rejected the premolar-extraction treatment option.

Based on the initial records and the patient’s desires, the treatment objectives were to distalize all mandibular teeth, improve the interincisal relationship to have normal overjet and overbite, shift the mandibular midline to coincide with the facial and maxillary midlines, and achieve Class I canine and molar intercuspal relationships. A conventional fixed appliance was prescribed.

**TREATMENT ALTERNATIVES**

Maxillary advancement surgery was not a viable treatment option because the skeletal deficiency was
not significant, and the patient was pleased with her facial appearance. Maximum anchorage and interarch elastics were discussed for en-masse movement of the mandibular dentition. She refused the interarch elastics because of their visibility. Her occasional clicking was also a matter of concern because it might lead to TMJ dysfunction symptoms during orthodontic treatment. Therefore, mandibular distalization with a C-implant in the posterior dentition and intra-arch elastics was the treatment of choice. After distal movement of the mandibular dentition, a full fixed appliance would be used in the maxillary dentition for finishing.

**TREATMENT PROGRESS**

Two C-implants, 1.8 mm in diameter and 8.5 mm long, were placed in the interdental spaces between the mandibular second premolars and first molars. Bone quality in the mandible was good, and the implants were loaded immediately. A 0.016-in NiTi initial archwire was used for leveling and distalization of the mandibular posterior dentition. Intra-arch elastics (1/4-in, 3.5 oz) were applied from the 0.7-mm-diameter stainless steel sliding jig to the neck of the C-implant for distalization of the mandibular second molar and anterior decrowding (Fig 6A).

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**Fig 4.** Pretreatment dental casts.

**Fig 5.** Pretreatment radiographs: A, panoramic; B, cephalometric.
The maxillary dentition was not bonded initially because the dental and facial midlines were coincident, and no forward movement of the anterior teeth was desired. While the mandibular dentition was distalizing, drifting occurred. Therefore, a power chain was applied to correct the midline (Fig 6B). This applied an intrusive movement to the mandibular incisors because the NiTi archwire was not stiff, and elastics were applied from the incisors to the apically placed C-implant. To correct the anterior open-bite tendency from the force direction of the elastics, the mandibular archwire was changed to a 0.016 × 0.022-in NiTi archwire and then a 0.016 × 0.022-in stainless steel archwire with closing loops (Fig 7).

As the mandibular molars moved distally, the maxillary molars were extruded. To correct the extrusion,
the maxillary dentition was bonded for intrusion and leveling of the maxillary molars. A Class I molar relationship of the mandibular left dentition was achieved by using a sliding jig. The mandibular right dentition was distalized 6 mm but still required further movement. The sliding jig was continuously applied to the mandibular first molar. The mandibular premolars continued to move separately (Fig 8). The closing loop of the 0.016 × 0.022-in stainless steel archwire was used as a hook for mandibular en-masse retraction. Distalization of the mandibular dentition and midline correction took 18 months. The fixed appliances were removed, and retention was provided by maxillary and mandibular fixed retainers.
TREATMENT RESULTS

The active treatment period was 18 months. The patient’s facial profile was mostly unchanged (Fig 9). A Class I canine and molar relationship and normal tooth alignment with better midline coincidence, and normal overjet and overbite were achieved (Figs 9 and 10). The maxillary incisors moved forward slightly. The mandibular incisors were retracted considerably and extruded. The upper and lower lips moved very little. The interincisal angle increased as the mandibular incisors uprighted and the ANB angle remained unchanged. The posterior facial height-anterior facial height ratio and the FMA were only slightly changed in spite of the significant mandibular molar distalization as seen in the superimposition (Fig 11).

The patient was pleased with the treatment results. An ideal incisor relationship and Class I canine and molar relationship were obtained. All radiographic (Fig 12) and clinical measurements were within acceptable limits. Lingual bonded retainers and wrap-around retainers were placed. Intraoral photographs after 8 months of retention (Fig 13) showed substantial relapse on the right side back to Class III molar and canine relationships and a shallow overbite. We asked the patient to wear the wraparound retainer more, and after 26 months of retention, the occlusal relationship was stable (Fig 14).

DISCUSSION

The entire mandibular dentition was distalized with intra-arch elastics and a supporting C-implant between
the second premolars and first molars bilaterally and without extrusion or forward movement of the maxillary dentition. Mandibular posterior distalization began with a NiTi wire for anterior decrowding and midline correction. After distalization and decrowding, anterior spacing was closed rapidly by using elastomeric chain from the C-implant. The implant site was based on cortical bone thickness, anatomic structures, and soft-tissue functional movements. Most reports suggest that the preferred site for arch distalization with skeletal

Fig 10. Posttreatment dental casts.

Fig 11. Cephalometric superimposition. Black, pretreatment; gray, posttreatment.
anchorage is the terminal molar. The retromolar area has been reported as an optimal placement site, offering a relatively thick cortical bone layer in the mandible. However, soft-tissue problems can occur around the screw implants because the soft tissue is usually thicker and more movable in the retromolar area than in other areas. This can result in inflammation, patient discomfort, and difficulty applying elastics or NiTi coil springs.

Alternative sites for posterior anchorage are the edentulous areas of the alveolar process and posterior alveolar bone. The alveolar bone around the posterior teeth can be the site of choice in patients without edentulous areas. Miniscrews can be placed between the roots of the posterior teeth without damaging the roots, because the cortical bone in these areas is not very thin.

Orthodontic mini-implants can be placed either between the first and second molars or between the second premolar and the first molar in the mandibular arch. The thickness of the cortical bone between the first and second molars is enough to provide primary stability, but this site is not recommended because of tissue irritation during mastication. Thus, the alveolar bone between the second premolar and the first molar might be a good choice for minimum discomfort and maximum stability. The mental foramen and mandibular canal can be avoided if the implant is placed not too far from the apex of the adjacent teeth.

We reviewed computed-tomography studies of interradicular space to prevent root damage. Park evaluated the computed tomography images and reported bone thicknesses and distances between roots 5 to 7 mm apical to the alveolar crest. The average distance between the roots of the mandibular second premolar and first molar was 3.47 mm (range, 2.0-4.8 mm). The distance between the roots of the mandibular first and second molars was 4.57 mm (range, 2.7-6.5 mm). Park et al found smaller distances of 2.4 to 3.3 mm between the second premolar and the first molar, and 2.8 to 3.7 mm between the first and second molars. The distances from the cortical bone surface to the interradicular space however, were relatively larger (3.7-4.2 and 5.3-7.0 mm, respectively). It follows that orthodontic implants 1.8 mm in diameter can be placed at a slight angle of inclination relative to the buccal cortical bone to overcome the limitation of minimum interradicular space.

The amounts of distal tooth movement have been reported previously. Saito et al reported 1.8 to 10.7 mm of tooth movement in a dog study. In another report, the average amounts of distalization of the mandibular first molars were 3.5 mm at the crown level and 1.8 mm at the root level. The average amount of relapse was 0.3 mm at both the crown and root apex levels. In a recent case report, the mandibular posterior teeth were distalized 6 and 4 mm on the right and left sides, respectively. Interarch elastics induce mandibular posterior intrusion by tip-back mechanics, instead of extrusion. Maxillary C-implants can also be used as anchorage for additional maxillary posterior intrusion. This allows selection of specific treatment mechanics for distalization based on the skeletal and facial pattern of patients.
Another issue of concern is the relationship between interarch elastics and temporomandibular disorders (TMD). According to a previous report, Class II interarch elastics were not related to TMD. However, Class III elastic usage in patients with subclinical TMD problems needs more careful consideration. Some authors suggested that a posteriorly positioned condyle is a common predisposing factor in anterior TMJ disc displacement. It has also been reported that interarch force might be an etiologic factor of TMD in animals. Although the exact cause of TMD is not completely understood, loading is at least considered a possible etiologic causes. Therefore, it might be prudent to create a treatment plan that minimizes condylar loading in patients with potential TMD problems.

A final issue of concern is the relationship between the long-term retention results and the entire dentition distalization method. We recommended the fixed retainer and wraparound retainer combined retention method to the patient and also encouraged her to chew...
on both sides after treatment. However, she accepted only the fixed retainers. Eight months after debonding, significant relapse on the right side was observed. The relapse tendency was assumed to be due to severe tipping of the mandibular molar distally, as can be seen in the cephalometric radiograph, and also to insufficient retention and habitual mastication on left side. Merrifield defined directional forces as those that use directional control to precisely position the teeth, and Lima and Lima showed 4 years of stable retention after mandibular dentition distalization treatment in a case report.

If the mandibular molars in our patient were controlled bodily by additional loop mechanics after tip-back movement, a more stable result was possible. The sliding jig application on a stiffer archwire would be better than only tip-back treatment methods for bodily distalization of molars. On the contrary, the distalized mandibular left dentition showed more stable retention compared with the right dentition. It was assumed that second molar distalizing began a week after the mandibular left third molar extraction, and the bodily tooth movement was possible because of relatively low cortical resistance on that side. Maxillary and mandibular wraparound retainers were used in this patient in that period, and she had a recall check 3 months later. After 26 months of retention, the patient did not show a significant relapse tendency as she had after 8 months of retention (Fig 14).

Mandibular premolar extraction without moving molars distally would perhaps have led to a more stable result. Despite the patient’s request, we should have persuaded her to select this simpler treatment option. However, the tip-back tooth movement and long-term retention results of this patient will be helpful for clinicians who consider similar treatment mechanics for patients with Class III anterior crossbite.

In cases of whole-dentition distalization, we recommend both a wraparound removable retainer and a fixed retainer, and that chewing be done on both sides. Class III intermaxillary elastics applied to a splint-type retainer with hooks for night wear can be a good alternative to conventional retention methods.

CONCLUSIONS

The C-implant can withstand heavier loads than other skeletal anchorage systems. It also has the advantage that its abutment head design can be used for elastic applications. In this case, the C-implant and multiple intra-arch elastics distalized the entire mandibular dentition independently, without extrusion or flaring of the maxillary dentition.

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REFERENCES


