Molar distalization with a partially integrated mini-implant to correct unilateral Class II malocclusion

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This article illustrates a new treatment system combining segmented wire and osseointegrated mini-implants for molar distalization without complex appliances. The procedures, advantages, efficacy, and indications for this method are discussed. Two patients whose treatment plans included distal molar movement and orthodontic mini-implant treatment were recruited. One patient required 1 molar to be uprighted, and the other needed molar distalization to regain space lost for the missing maxillary right second premolar. C-implants (diameter, 1.8 mm; length, 8.5 mm) were placed and, after 4 weeks of healing, were used as direct anchorage and indirect anchorage simultaneously for correcting the asymmetric Class II molar relationship. Few orthodontic attachments were necessary, and the teeth moved rapidly to the planned positions without detrimental effects on the occlusion. The combination of segmented archwires, minimum bonded attachments, and a partially osteointegrated mini-implant (C-implant) was a simple and effective treatment choice in distalization treatment. (Am J Orthod Dentofacial Orthop 2010;138:810-9)

Unilateral full-step Class II correction, with asymmetry in the maxillary arch, can pose a challenge for the orthodontist. Although various treatment modalities have been developed and used successfully over the years, many need intensive cooperation from the patient. Noncompliant mechanics can be complicated and cumbersome. Unilateral premolar extraction is usually an available treatment option but can result in arch skewing or displacement of the midline.

Headgears can be adjusted to provide a distalization force on the Class II side. 1-3 Removable appliances designed to distalize molars have been advocated, but both approaches require much patient cooperation. 4,5

Fixed functional devices can provide a distalization force to the maxillary posterior teeth but also influence the mandibular dentition. 6,7 Pendulum appliances and distal jets have been advocated and proven successful for molar distalization. However, there are disadvantages, including laboratory time and expense. Whereas these appliances incorporate design components to attempt to prevent anchorage loss, flaring of the anterior teeth and increased overjet usually take place to a significant extent. One negative sequela usually seen with these appliances as posterior teeth distalize is increased lower facial height because of clockwise mandibular autorotation. 8-11

In more recent years, treatment mechanics with skeletal anchorage combined with pendulum springs have been devised primarily for molar distalization. However, these biomechanical systems are somewhat complex and require significant laboratory time and expense. The distalization process is also delayed because of the waiting period for these palatal implants to achieve osseointegration. 12-15 Sugawara et al 16 demonstrated the distalization capability of a skeletal anchorage system involving titanium anchor plates. Although effective, the surgical placement of a miniplate is more difficult and invasive than that of a mini-implant. Park 17 showed the possibility of full-arch distalization using mini-implants. However, these mini-implants acted as auxiliaries for continuous archwire systems during the whole orthodontic treatment.

We present 2 patients who had limited treatment incorporating unilateral molar distalization with skeletal anchorage. The skeletal anchorage was provided by a C-implant, introduced as a partially integrated mini-
implant system (Cimplant, Seoul, Korea). These relatively simple treatment mechanics use direct or indirect anchorage to achieve efficient, bodily molar distalization, while minimizing undesirable vertical dimension changes.

The biomechanics of molar distalization with pushing mechanics use partially osseointegrated C-implants. A C-implant is composed of titanium grade V alloy; it is self-tapping and threaded. Each C-implant has 2 components: the screw part has a diameter of 1.8 mm, and the head part measures 2.5 mm in diameter. The head is inserted into the screw and tapped into place. Precise fit and friction retain the head during treatment. The screw surface is sandblasted large grit and acid-etched treated for optimal osseointegration except for the upper 2 mm that is in contact with soft tissues. Upper and lower structures are mechanically interoriented; this means that they can have many variations. Especially, the head part can have different lengths and different numbers of holes. According to the treatment objectives, the head part can be changed in midtreatment, without the need to remove the implanted screw. The 0.8-mm diameter hole of the head part can receive archwires (Fig 1, A).

C-implants can provide absolute anchorage with the advantage of resistance to rotation force and high stability during force application. Direct anchorage can be obtained by using a segmental archwire with an open-coil spring to push the teeth independently (Fig 1, B and C). Intrusive step bends are usually made to the segmented archwire to minimize the extrusion tendency during distalization. Indirect anchorage can also be established by attaching a wire ligation wire from the C-implant to a bracket anterior to the mini-implant. Mesial movement of anterior teeth can thus be prevented.

CASE REPORTS

Patient 1

A man, aged 42 years 7 months, had a chief complaint of loss of the maxillary right first molar and mesial inclination of the second molar. This condition followed the extraction 2 years previously of the first molar after a vertical fracture (Figs 2 and 3, A-C). Pretreatment intraoral photographs showed bilateral Class I canine relationships, and a Class I molar relationship on the left side. There was a full-step Class II second molar relationship on the right side because of mesial drifting after the first molar extraction. There was a slight anterior open-bite tendency. The maxillary and mandibular midlines were coincident.

A panoramic radiograph at the initial examination showed mesial drifting and tipping of the maxillary right second molar (Fig 3, D). An implant fixture had been placed into the missing molar position 2 months previously. The implant was close to the second premolar due to inadequate space for placement at the time of surgery (Fig 3, D). The missing maxillary right first molar allowed mesial inclination of the maxillary right second molar into a full-step Class II second molar relationship. The treatment plan was to place a partially osseointegrated mini-implant that could endure heavy and dynamic forces in the interradicular space.
between the maxillary right first and second premolars. A segmental archwire with an open-coil spring was planned to move the second molar distally into a Class I second molar relationship.

A C-implant (diameter, 1.8 mm; length, 8.5 mm) was implanted in the interradicular space between the maxillary first and second premolars with a 45° apical angulation to the long axis of the teeth (Fig 4). The angular placement of the mini-implant allowed for less chance of root contact because of greater interradicular space in the apical areas of the roots²⁶ (Fig 5).

The segmental stainless steel wire (0.017 × 0.025 in) was placed into the hole of the C-implant head to the archwire slot of the second molar, and light orthodontic force (50 g) was applied with an open-coil spring immediately because that maxillary second molar showed fast mesial tipping tendency in a short period (Fig 6, A). One month later, a crimpable hook was placed on the archwire to activate the open-coil spring, and intrusive step bends were made to the segmental archwire to prevent the extrusion tendency of the second molar (Figs 6, B, and 7, A). The patient was examined every 4 weeks to monitor progress (Figs 6, C and D, and 7, B and C). Selective grinding was done on the second molar to eliminate premature contacts as the tooth distalized. Two months later, the second surgery for the restorative implant was done. Four months later, distal movement was stopped, and the prosthesis was delivered.

The final photographs and the panoramic radiograph show that adequate uprighting of the second molar provided sufficient space for an implant crown with normal dimensions (Figs 7, D, 8, and 9). The patient’s preexisting occlusion was maintained. An anterior open-bite tendency remained, but a minimal increase in the anterior open bite was noted during treatment. In this minor tooth-movement case, bracketing was limited to the maxillary right first molar only (Fig 10). The total treatment time was 3 months, after which
the implant prosthesis was delivered in the regained space (Fig 10). The C-implant was also stable during the total treatment and successfully removed by using topical anesthesia.

**Patient 2**

A woman, aged 22 years 7 months, visited for an orthodontic consultation. Her chief complaints were crowding and jaw pain. She had a Class II Division 1 subdivision left malocclusion. A Class I molar and canine relationship was noted on the left side. On the right side was a full-step Class II molar relationship. The right canine was in Class III due to the maxillary midline drift to the right. The maxillary right second premolar was extracted because it was a blockout tooth, allowing mesial drifting of the first and second molars (Fig 11). The mandibular midline was coincident with the facial midline. The maxillary midline was to the right 2 mm, because of the previous second premolar extraction. Mesial inclinations of the maxillary right first, second, and third molars were noted in the pretreatment panoramic radiograph. There were 2 treatment options: to maintain the asymmetric key relationship only by conventional treatment mechanics, and to recapture the premolar space to achieve a Class I symmetric key relationship. The patient requested the space-regaining treatment for the extracted premolars without changing the midline condition.

**Fig 4.** Placement procedures of C-implant in the first patient: A-C, screw part placement after pilot drilling; D-F, head part adaptation with head tapper.

**Fig 5.** Postplacement panoramic radiograph of the first patient.

Therefore, the treatment goals involved recapturing the space for the missing premolar and treating the patient without extractions except the lower impacted third molars. Skeletal anchorage would allow distalization of the maxillary right molars. After physical therapy and 2 months of stabilizing splint therapy, the temporomandibular joint symptoms disappeared.

The mandibular third molars and the maxillary right third molar were extracted. To improve the molar intercuspation and reestablish a Class I occlusion on the right side, a C-implant (diameter, 1.8 mm; length, 8.5 mm) was placed in the interradicular space between the maxillary right canine and the first premolar, with a $75^\circ$ apical angulation to the long tooth axis of the teeth because of sufficient interradicular space. A 0.017 ×
0.025-in stainless steel segmented archwire was placed that included the maxillary right canine to the right second molar (Fig 12, A). Indirect anchorage was provided by placing a ligature wire from the C-implant to the canine bracket, and the distalization process was begun with an open-coil spring between the first and second molars. At a subsequent appointment, direct anchorage was added with a second segmental 0.016 × 0.022-in stainless steel archwire from the C-implant to the first molar utility arch slot, with the open-coil spring delivering the 100 g of distal force (Fig 12, B, C, and G). The remaining full maxillary arch bonding was done after
A Class I molar relationship was established (Fig 12, D, E, and H). Distal movement of the second molar was observed, and excessive mesial movement of the canine was prevented by the indirect anchorage from the ligature wire. Distalization of the first and second molars was accomplished by using full and segmental archwires, along with the open-coil spring to provide a distalizing force (Fig 12, E). To provide further anchorage, a transpalatal stabilization wire was placed on the right and left first premolars (Fig 13).

The final photographs and radiographs show adequate molar distalization, with sufficient space for implant placement and restoration of the second premolar (Fig 14). Class I molar and canine relationships were reestablished on the right side. The maxillary and mandibular midlines were coincident. Retention was accomplished with maxillary and mandibular fixed retainers. The final panoramic radiograph showed no evidence of root resorption of the maxillary anterior teeth. Although greater mesial root tipping of the maxillary right first premolar would have been ideal, sufficient mesiodistal space was recaptured to make restoration of the second premolar possible (Fig 14). The total treatment time was 12 months; then an implant and a crown were placed. The C-implant was stable during the total treatment period and successfully removed with topical anesthesia.
DISCUSSION

These 2 patients both had indirect and direct implant anchorage to distalize and upright the molars. Without implant anchorage, appliance complexity and biomechanic demands would have been much greater. Implant anchorage with a partially osseointegrated mini-implant (C-implant) permitted the use of few orthodontic attachments. Others have suggested similar tactics. Park et al27 showed a new molar uprighting method with miniscrew anchorage in the retromolar area. Lee et al28 suggested direct miniscrew anchorage without the assistance of anchorage teeth for uprighting the mandibular second molars. They mentioned that direct application of force from the mini-implant to the target tooth eliminates the possibility of unwanted movement of the anchorage unit that can occur even with indirect miniscrew anchorage as a result of technical errors in passive bracket placement or a weak attachment between the miniscrew and the anchor tooth. Whereas they advocated the principle of minimum usage of a conventional mini-implant for the maximum uprighting effect, they also showed the application of multiple mini-implants for uprighting 1 tooth.

In the clinical report of Derton et al,29 several miniscrews were used for 3-dimensional movement of tipped molars. Gracco et al30 also suggested the innovative uprighter jet for preventing molar extrusion during the uprighting procedure. But complex distalization appliances were needed, and the mini-implant was positioned in an edentulous area.

We suggest using a partially osseointegrated mini-implant because it allows easier and more accurate application of force and vector, and even a rotational force without dislodging the implant.31 A partially osseointegrated mini-implant can be placed toward the front of the mouth with support lever arms that transfer force and vector distally. Similar to a molar tube, the hole of the C-implant head can support multiple forces or moments that are sufficient to upright or distalize a lingually tipped or rotated molar. This is a big advantage in asymmetric movement of individual teeth, since the force vector is better controlled. Removal of the C-implant after active treatment is not difficult.

Even though a 4-week healing period is usually required for optimal osseointegration, a C-implant for these mechanics was used immediately after placement. The first patient had a rapid tipping tendency of the target teeth (maxillary right second molar); therefore, we decided to maintain the position of the second molar using 0.017 × 0.025-in stainless steel wires and a slight open-coil spring activation through the C-implant hole. The segment wire was applied to the C-implant hole passively, and the initial force was about 50 g. After 1 month of activation, the pushing force was increased to 150 g, and intrusive bending was performed to the segment archwire. Also, the C-implant in the second patient needed to resist a light static load (Fig 12, A) at an initial force after placement.

Also, this patient had a narrow interradicular space between the maxillary right first and second premolars. If a mini-implant with 6-mm bone contact is
placed at $45^\circ$ to the dental axis, the distance can be calculated as 6 mm of actual length of the screw part multiplied by $\cos 45^\circ = 4.24 \text{ mm}$.\textsuperscript{26} A little more angulation can be another choice if the mini-implant will be placed in a narrow interradicular space such as this patient had.

Fig 12. Treatment progress of the second patient: A, a 0.17 x 0.025-in stainless steel segmented archwire was placed that included the maxillary right canine to the right second molar. A C-implant (diameter, 1.8 mm; length, 8.5 mm) was placed between the maxillary right canine and first premolar and used as indirect anchorage for molar distalization. B-D, At a subsequent appointment, direct anchorage was added with a second segmental .016 x .022-in stainless steel archwire from the C-implant to the first molar utility arch slot, with the open-coil spring delivering the distal force. E, The remaining full maxillary arch bonding was done after a Class I molar relationship was established. F, All the bonded appliances were removed after distalization. G, Panoramic radiograph 6 months after immediate force application. H, Panoramic radiograph 11 months after force application.

It is simple to activate the coil spring against the target tooth by using a crimpable surgical hook. The clinical tip to prevent the segmented wire from slipping out of the C-implant during tooth distalization is to squeeze the extended helix of the segmented archwire in the front of the head part (Fig 12, B and D).

These 2 patients had a slight bite-opening tendency during distalization, even though an intrusive force was applied to the segmented archwire from the C-implant, probably because of the slight extrusion tendency of the distalized teeth. Intrusive step bends were made to the segmented archwire during the
finishing stage. We should have applied the intrusion bends earlier in these patients. However, the healing periods were insufficient for secondary stability of the mini-implant in the first patient because of the rapid tipping tendency of the maxillary second molar. Also, a ligature wire to the mini-implant in the second patient was insufficient for indirect anchorage (Fig 12, B and C).

In patients who need torque control of the target teeth, the clinician can fix a rectangular wire segment into the hole in the implant head with composite resin. The partially osseointegrated C-implant will support this kind of force application.

These clinical reports illustrate the use of the C-implant, with minimal orthodontic attachments and coil-spring biomechanics to distalize tipped and rotated molars.

Fig 13. Treatment progress occlusal photographs of the second patient: 0.9 mm diameter stainless steel bonded transpalatal archwire was applied during asymmetric teeth distalization.

Fig 14. Posttreatment intraoral photographs and panoramic radiograph of the second patient.
REFERENCES