Timely relocation of mini-implants for uninterrupted full-arch distalization

Kyu-Rhim Chung,[a] HyeRan Choo,[b] Seong-Hun Kim,[c] and Peter Ngan[d]
Seoul, Korea, Philadelphia, Pa, and Morgantown, WVa

This report describes a novel concept of relocating orthodontic mini-implants during dental distalization to provide unrestricted distal movement of the full maxillary dentition. The patient was an 18-year old Korean woman with a full-step Class II Division 1 malocclusion and mandibular deficiency. Mini-implants were initially placed bilaterally between the maxillary second premolar and the first molar. Sliding jigs were used to distalize the maxillary first and second molars. After the maxillary molars were distalized to a Class I molar relationship, the mini-implants were removed and immediately relocated distally to provide space for retraction of the anterior teeth. The occlusion was completed with Class I molar and canine relationships with optimal overjet and overbite. The 2-year posttreatment records showed a stable treatment with retention. (Am J Orthod Dentofacial Orthop 2010;138:839-49)

Within the last decade, the use of mini-implants as temporary anchorage devices has greatly expanded the boundaries of orthodontic tooth movement.[1] Individual teeth or an entire dental arch can now be moved accurately in 3 planes of space with minimal loss of anchorage.[2-5] Many articles have discussed the different biomechanical designs integrating the concepts of mini-implants,[6] risk factors associated with mini-implants,[7] and parameters that can increase or decrease the stability of mini-implants.[8] Mini-implants, if used properly, can serve as an alternative treatment option for patients who require orthognathic surgery by assisting in full-arch distalization or changing the occlusal plane with full-arch intrusion.[9]

The treatment for patients with Class II Division 1 malocclusion and mild skeletal mandibular deficiency can be camouflaged by distalization of the entire maxillary dentition. Numerous designs for molar distalization appliances have been reported in the literature including the Hilgers pendulum appliance,[10] the Cetlin headgear and removable appliance,[11] the Jones jig distalization apparatus,[12] and open nickel-titanium (NiTi) push coils.[13] Most of these devices suffer from a loss of anterior anchorage and relapse after removal of the distalization appliance. Although the use of mini-implants to overcome these problems has been reported in the literature, separate and multiple mini-implants are usually necessary for successful distalization of the maxillary molars and retraction of the anterior teeth.[14-17]

This case report describes a novel biomechanical technique for distalizing the entire maxillary dentition by relocating the mini-implants immediately after their removal. This technique helps to reduce the cost of using several mini-implants during treatment and expedites the overall orthodontic treatment progress.

DIAGNOSIS AND ETIOLOGY

The patient was an 18-year-old Korean woman whose chief concern was "crooked front teeth." The intraoral examination showed a full-step Class II Division 1 malocclusion with bidentoalveolar protrusion and moderate-to-severe crowding of the anterior teeth (Figs 1 and 2). The cephalometric analysis showed a skeletal Class II pattern with an ANB angle of 5°, excessive proclination of the maxillary and mandibular incisors with a U1-NA angle of 36°, an L1-NB angle of 41°, and an interincisal angle of 98° (Fig 3, Table).

TREATMENT OBJECTIVES

The treatment objectives were to (1) camouflage the skeletal malocclusion by distalization of the entire

[a]President, Korean Society of Speedy Orthodontics, Seoul, Korea.
[b]Orthodontist, Children's Hospital of Philadelphia, Department of Orthodontics, University of Pennsylvania, Philadelphia.
[c]Associate Professor, Department of Orthodontics, School of Dentistry, Kyung Hee University, Seoul, Korea.
[d]Professor and chairman, Department of Orthodontics, School of Dentistry, West Virginia University, Morgantown.
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Reprint requests to: Seong-Hun Kim, Department of Orthodontics, School of Dentistry, Kyung Hee University #1 Hoegi-dong, Dongdaemun-gu, Seoul 130-701, South Korea; e-mail, bravortho@khu.ac.kr and bravortho@hanmail.net.
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Fig 1. Pretreatment extraoral and intraoral photographs show bidentoalveolar protrusion with moderate-to-severe crowding in the anterior incisor region.

maxillary arch, (2) correct the molar and canine relationships to Class I with mutually protected canine guidance, (3) achieve optimal overjet and overbite, and (4) improve the facial balance.

TREATMENT ALTERNATIVES

Based on the above objectives, 2 treatment options were proposed. Both plans required the extraction of all third molars. The ideal treatment option involved the extraction of both maxillary and mandibular first premolars. However, the patient adamantly refused extraction of any permanent teeth. Therefore, the second treatment option was accepted by the patient; it required the use of temporary skeletal anchorage devices (mini-implants) to distalize the entire maxillary arch to correct the molar relationship, overjet, and overbite with extraction of only the third molars. The patient was also informed that this process would occur in several stages: (1) upright the mandibular posterior teeth and resolve the crowding of the mandibular incisors, (2) distalize the maxillary posterior teeth, (3) retract the maxillary anterior teeth, and (4) coordinate both arches to achieve ideal overbite and overjet in the final detailing.

TREATMENT PROGRESS

A 2-component mini-implant (diameter, 1.8 mm; length, 8.5 mm) (C-implant, CIMPLANT, Seoul, Korea) was placed bilaterally in the interradicular position between the maxillary second premolar and the first molar. The patient was then referred for removal of the third molars before the placement of the orthodontic appliances. Fixed appliances were first placed in the mandibular arch with omega loops mesial to the second molars to serve as stops in the tip-back mechanics.

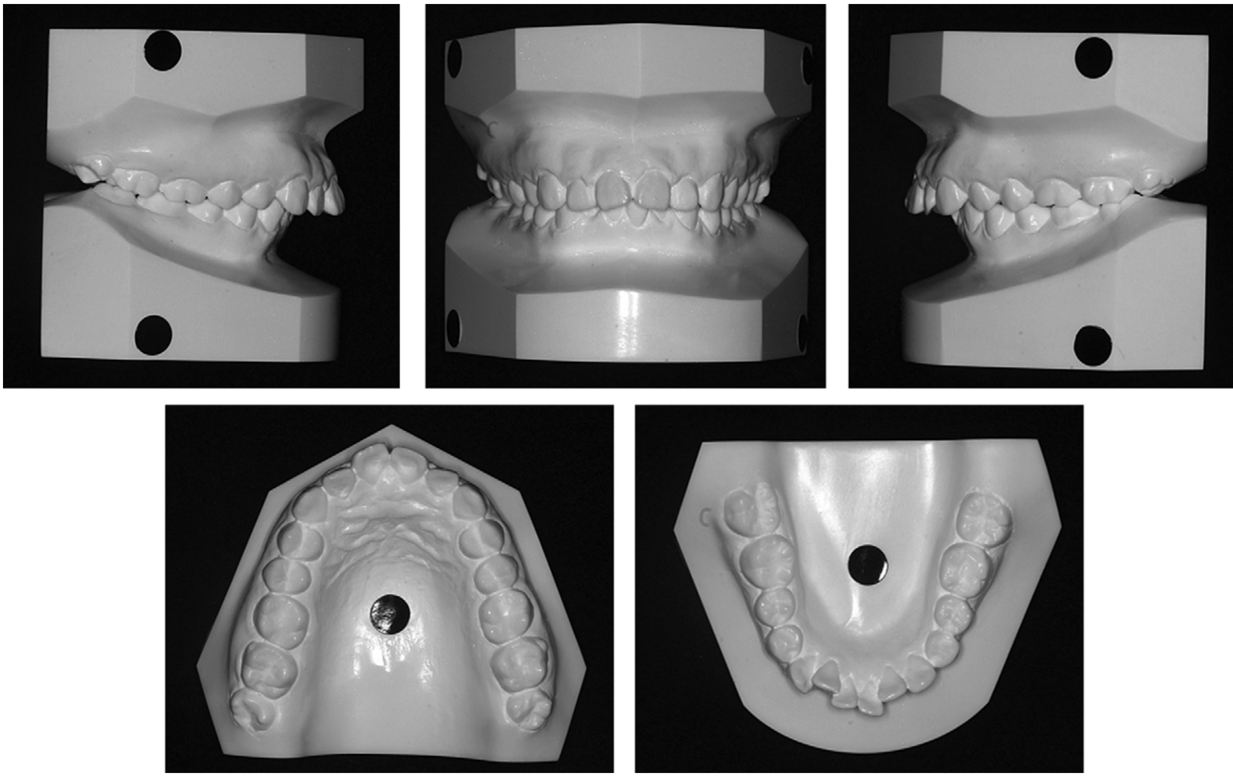

Fig 2. Pretreatment study models.

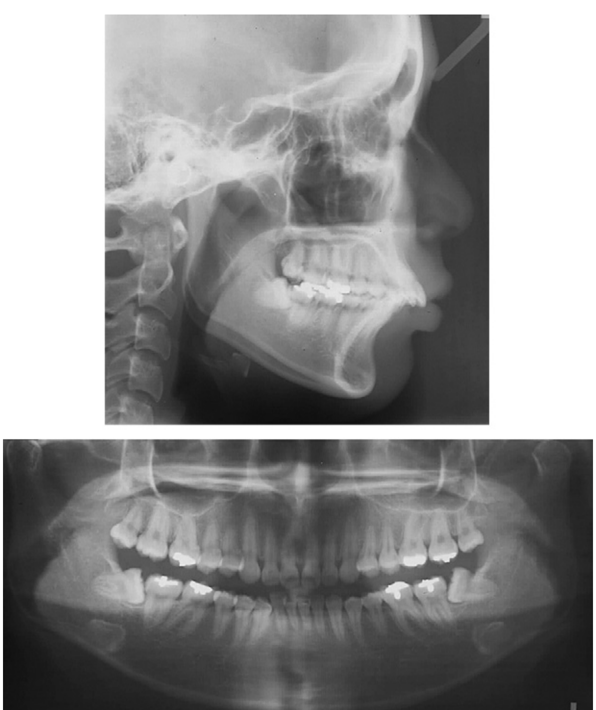

Fig 3. Pretreatment radiographs.

Table. Cephalometric survey

	*Female average**	*Pretreatment*	*Posttreatment*	*2 years retention*
SNA (°)	81.6	79.4	80.3	80.4
SNB (°)	79.2	74.5	74.9	74.3
ANB (°)	2.4	4.9	5.4	6.1
PFH/AFH (%)	(66.8%)	66.1	67.4	68.9
SN-OP (°)	17.9	16.5	20.5	19.3
FH-UI (°)	116.0	124.5	111.3	111.9
FMA (°)	24.3	24.4	22.5	20.4
IMPA (°)	95.9	113.1	110.3	111.8
FMIA (°)	59.8	42.5	47.2	47.8
UL-E plane (mm)	–0.9	2.9	0.2	–0.4
LL-E plane (mm)	0.6	3.1	0.2	0.2
Interincisal angle (°)	123.8	98.0	115.9	115.8
Mx 1 to NA (mm)	7.3	9.8	2.4	2.7
Mx 1 to NA (°)	25.3	35.8	21.7	22.0
Mn 1 to NB (mm)	7.9	9.1	7.25	7.8
Mn 1 to NB (°)	28.4	41.3	37.0	36.0
SN to PP (°)	10.2	6.4	6.1	5.7

*For Korean women, data from Korean Association of orthodontists.[23]

Mandibular molar uprighting began by using Class III elastics connecting the maxillary mini-implants to hooks soldered mesially to the mandibular canines on

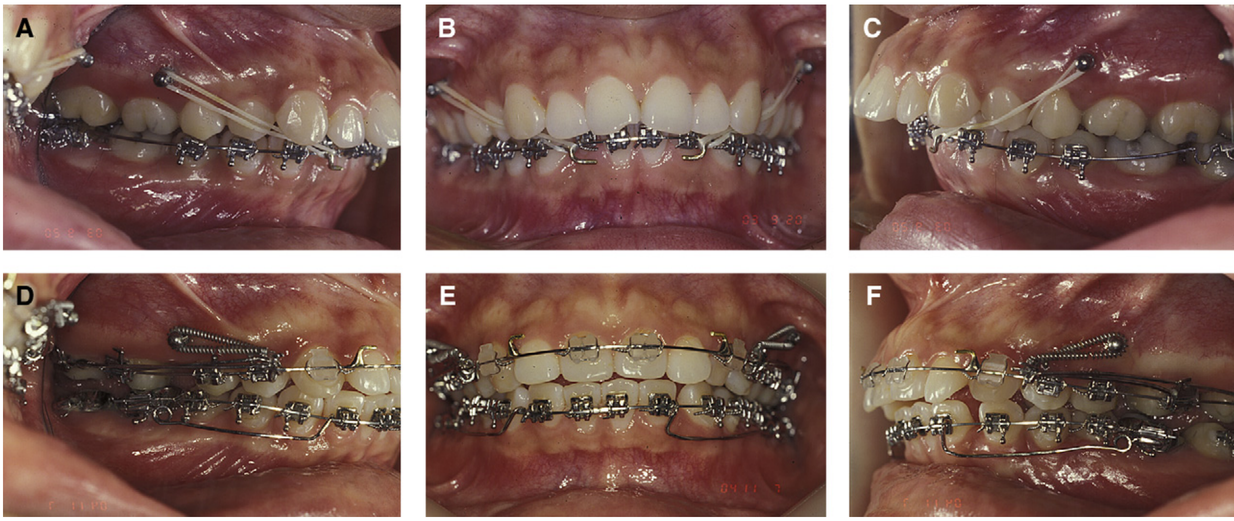

Fig 4. **A-C**, Step 1: mini-implants were placed bilaterally between the maxillary second premolar and the first molar. All third molars will be extracted after mini-implant placement. Orthodontic treatment begins with leveling and aligning of the mandibular dentition while minimizing undesirable proclination of the mandibular incisors with Class III elastics from the mini-implants. Omega loop stops mesial to the mandibular second molars with the Class III elastics induce distal tipping of the mandibular second molars during the initial dental aligning and leveling. **D-F**, Step 2: band and bond the maxillary arch. NiTi closed-coil springs anchored against the mini-implants were used to bilaterally distalize the maxillary first and second molars by attaching the coil springs to each distal jig. The mandibular first molars were subsequently banded, and uprighting springs were placed to tip the mandibular first molar distally while intruding the mandibular anterior teeth.

a 0.017 × 0.025-in mandibular stainless steel archwire (Fig 4, *A-C*). The maxillary fixed appliance was then placed, and closed-coil NiTi springs were used bilaterally, connecting the mini-implant to a sliding jig for distalization of the maxillary first and second molars into a Class I molar relationship (Fig 4, *D-F*). Concurrently, molar uprighting springs were used to continuously upright the mandibular molars by creating a coupling moment in bite-opening mechanics. The completion of this step generated a significant amount of interdental space between the second premolar and the first molar that would be used for retraction of the anterior dentition. The mini-implant was then relocated to a more distal position in the interradicular space between the maxillary right first and second molars and mesially to the maxillary left first molar.

The distalization technique started with placement of the mini-implants in the interradicular region between the maxillary first molars and second premolars. The maxillary molars were first distalized with either Class I intramaxillary elastics or NiTi closed-coil springs in combination with sliding jigs. After the maxillary molars were fully distalized into a Class I molar relationship, the need for relocation of the mini-implants to provide space for retraction of the anterior teeth was carefully evaluated. Periapical x-rays and panoramic radiographs or cone-beam computed tomography can be used to determine the availability of interradicular space between the maxillary first and second molars.

Local anesthesia was administered with approximately a quarter ampule of lidocaine (about 0.45 mL) near the initial mini-implant sites. The mini-implant head was removed by passing a dental explorer tip through the hole of the head and turning it in a counterclockwise direction (Fig 5, *A*). After removal of the mini-implant head, the body of the mini-implant was manually unscrewed with a hand screwdriver (Fig 5, *B*). The surface of the removed mini-implant was gently irrigated with saline solution, and the mini-implant was kept in a sterile isolation capsule. After mini-implant removal, a small cortical perforation was made at the new placement site by using a 1.5-mm diameter guide drill (Stryker Leibinger, Freiburg, Germany) at 1000 rpm (Fig 5, *C*). When a small, continuous stream of blood was observed during the pilot drilling, the preparation for the placement of the mini-implant at the new location was considered complete. The

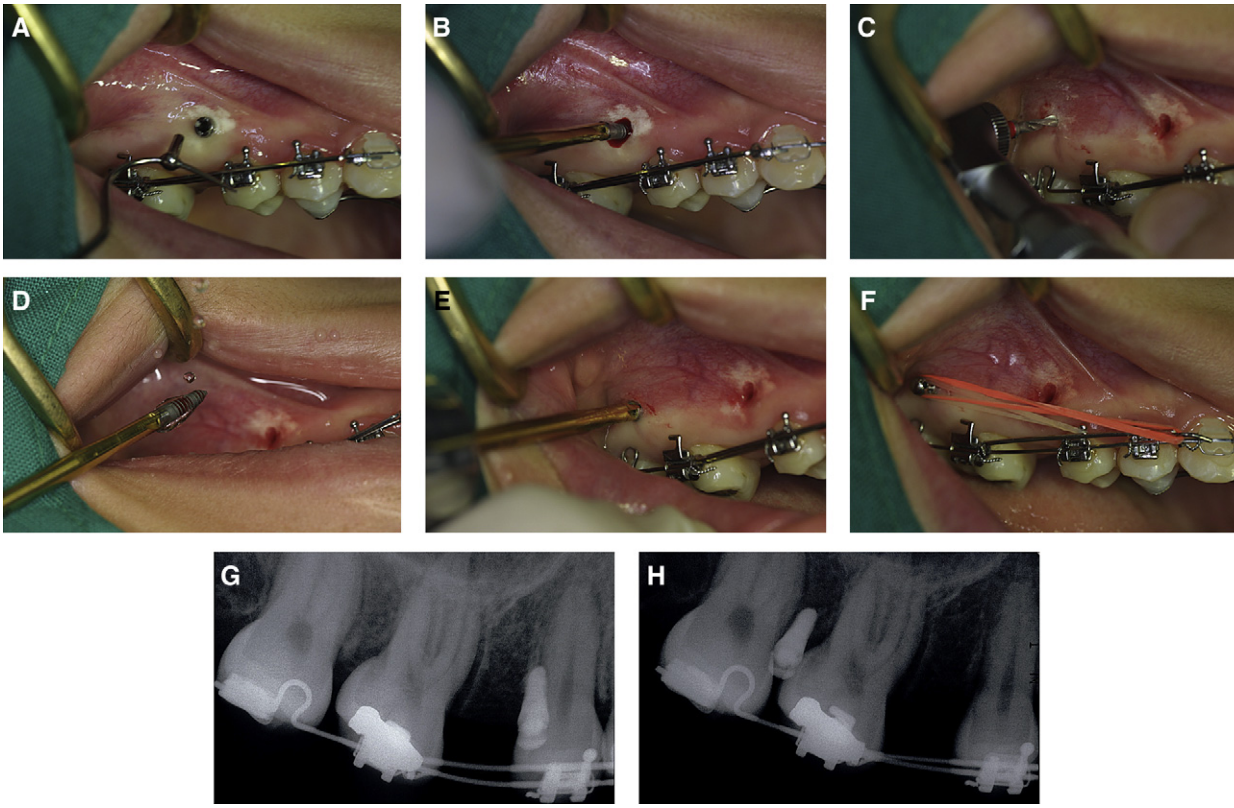

Fig 5. Surgical removal and immediate relocation of the 2 component mini-implants (C-implants): **A**, the head of the mini-implant assembly was removed with an explorer; **B**, the body of the mini-implant was removed with the screwdriver included in the kit; **C**, pilot drilling for the new location of the removed mini-implant between the distalized maxillary first molar and the second molar; **D-F**, the body of the mini-implant, removed from the original site, was immediately placed at the new location, with its relocation completed by tapping its head with a small mallet, and it is immediately loaded with elastics; **G** and **H,** periapical radiographs of C-implants before and after, respectively, the immediate relocation.

clinician must ensure that the hex of the mini-implant body is always firmly engaged by the screwdriver to prevent disengagement of the mini-implant body while placing it in the new location. The diameter of the mini-implant body was 1.8 mm, and the mini-implant screw had self-tapping properties. Therefore, gentle but firm pressure with clockwise rotation of the screw was necessary during placement of the mini-implant in the new interradicular space (Fig 5, *D-F*). No irrigation or suction is recommended during mini-implant placement, since maximum contact between the patient's blood and the surface of the mini-implant seems to work more favorably in achieving stability of the mini-implant in the cortical bone. Another set of periapical radiographs was taken immediately after mini-implant placement to verify its successful relocation (Fig 5, *G* and *H*). After verification, the mini-implant head was then gently tapped back into the mini-implant body with a small mallet. The newly placed mini-implants were immediately loaded by using Class I intramaxillary elastics with a force of approximately 150 g, connecting the mini-implants to the soldered hooks of the maxillary archwire mesially to the canines to initiate retraction of the maxillary anterior teeth (Fig 5, *F*). Most clinical relocation procedures do not require antibiotic prophylaxis and high levels of analgesics.

Finishing and detailing were then performed to establish a solid functional occlusion with ideal overbite and overjet (Fig 6). Figure 7 shows a series of cephalometric radiographs depicting the changes in the maxillary arch during the distalization of the posterior and anterior teeth.

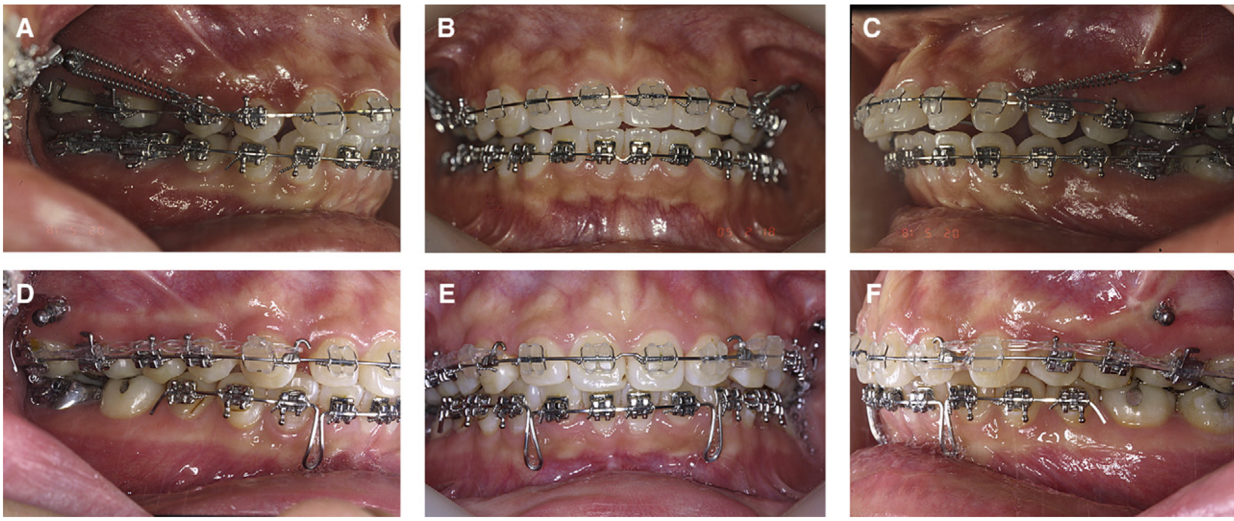

Fig 6. **A-C**, Maximum retraction and decrowding of the anterior maxillary dentition by using closed-coil springs anchored against the newly repositioned mini-implants; **D-F**, finishing details for maximum intercuspation in the Class I molar and canine relationships.

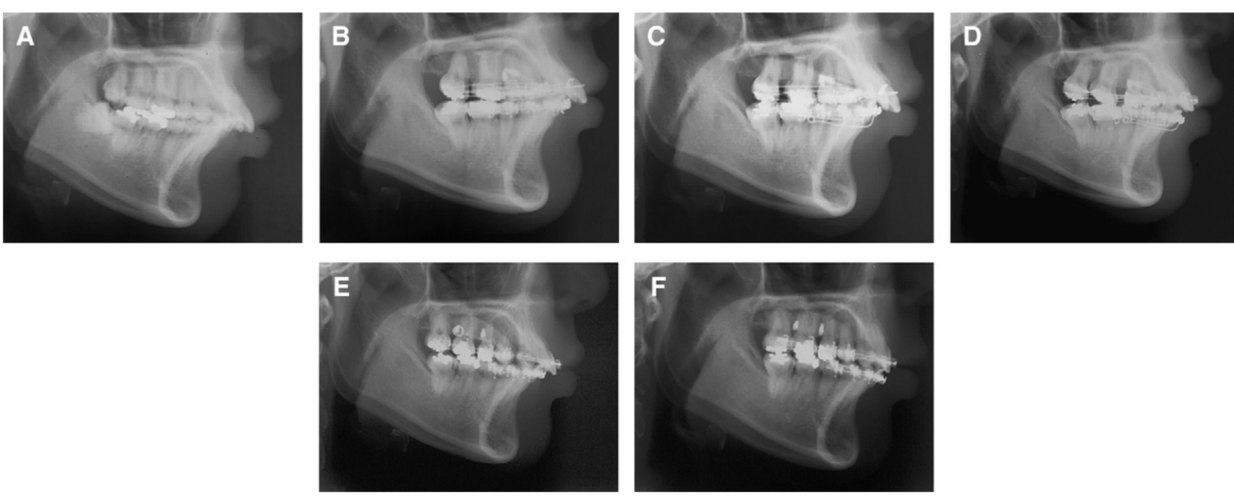

Fig 7. Treatment progress lateral cephalograms: **A**, pretreatment; **B**, distalization of the maxillary second molars; **C** and **D**, distalization of the maxillary first molars; **E**, after relocation of the mini-implant; **F**, finishing and detailing after anterior retraction.

TREATMENT RESULTS

In general, the result for this patient was excellent, and her cooperation with rubber-band wear was good. Figures 8 and 9 show the patient's final results on the day of debanding after 30 months of orthodontic therapy. The molar and canine relationships were corrected from full-step Class II to a Class I relationship. The maxillary incisors were retracted to improve lip competency and the overall soft-tissue profile. In addition, the treatment resulted in increased lower-face height and improved facial balance.

Figure 10 and the Table show the posttreatment cephalometric findings. The interincisal angle was corrected from 98° to 115.9°, which is much closer to the Korean female norm of 123.8°. The improvement in the interincisal angle resulted primarily from retroclination of the maxillary incisor (Mx 1 to NA, from 35.8° to 21.7°). The mandibular incisors were also slightly

Fig 8. Posttreatment extraoral and intraoral photographs: within 1 week of mini-implant removal, the tissues have completely healed, and there is no visible evidence of prior mini-implant placement.

retracted (IMPA, from 113.1° to 110.3°. The distance between the tip of the maxillary incisors and the NA decreased from 9.8 to 2.4 mm (average, 7.3 mm); this confirms bodily movement of the maxillary incisors. The posttreatment values of the maxillary incisor to the maxilla (slightly retroclined relative to average norms) and the mandibular incisor relationship to the mandible (proclined relative to average norms) suggested that dental compensation remained after the orthodontic therapy to camouflage the preexisting skeletal discrepancy (pretreatment ANB, 4.9°).

Superimposition of the pretreatment and posttreatment cephalometric radiographs (Fig 11) confirmed the bodily distalization of the maxillary molars, retraction of the maxillary incisors, uprighting of the mandibular molars, and retraction of the mandibular incisors. As expected for an 18-year-old woman, minimal growth changes were observed in the cranial base, maxilla, and mandible. The maxillary molars were intruded with corollary eruption of the mandibular molars resulting in the observed change in the occlusal plane. Pretreatment and posttreatment panoramic radiographs showed root parallelism after distalization treatment (Figs 3 and 10).

Figures 12 and 13 show the stability of the occlusion 2 years after removal of the orthodontic appliances. In general, the dentition was stable with fixed retention from canine to canine in both arches. The superimposition of the posttreatment and 2-year retention radiographs (Fig 13, *B*) showed minimal movement of the molars and incisors. Figure 14 compares the changes in the facial profile during the treatment and posttreatment periods. Improvement in facial convexity and vertical facial proportions were observed, and the soft-tissue changes were stable during the retention period.

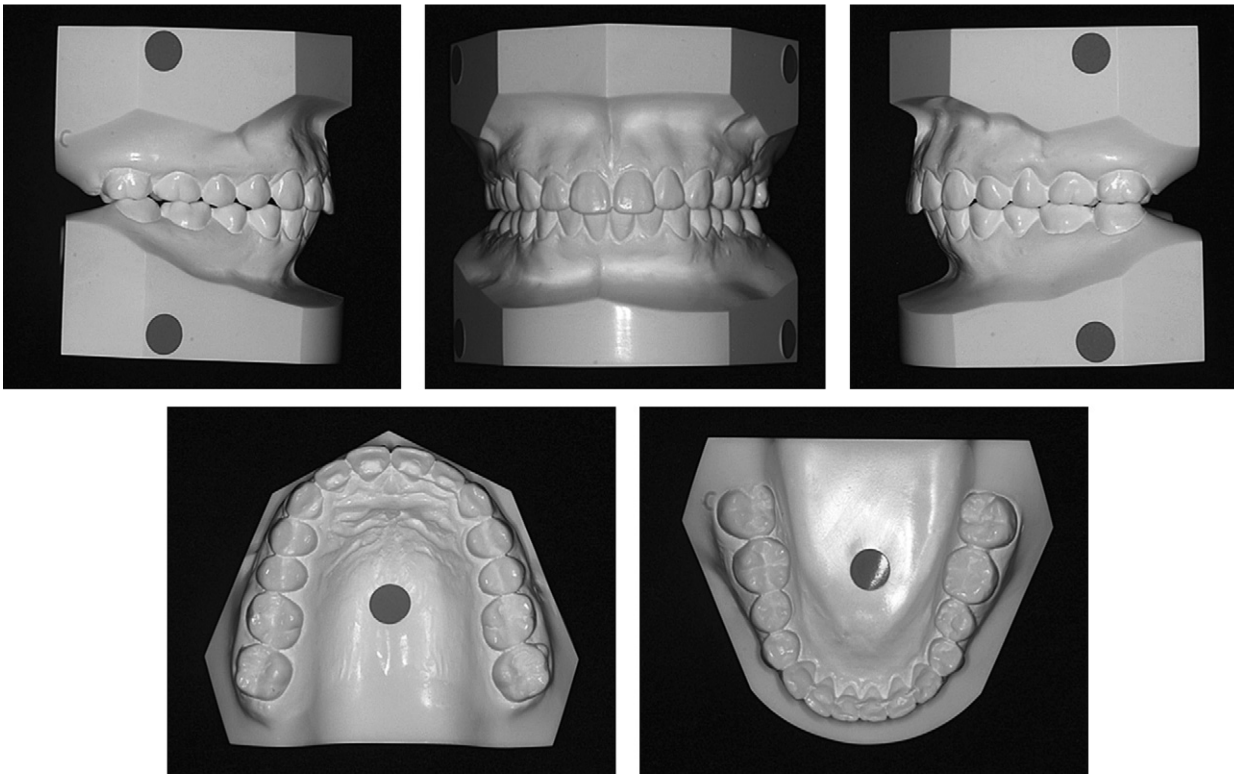

Fig 9. Posttreatment study models.

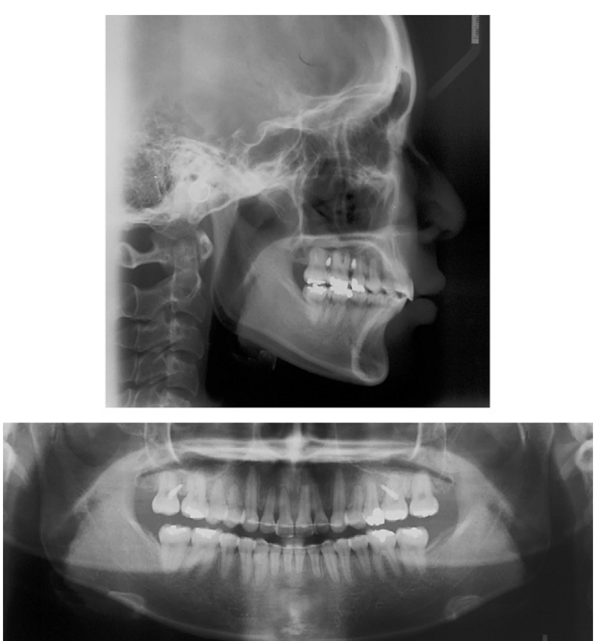

Fig 10. Posttreatment radiographs. Note the significant reduction of dentoalveolar proclination of the maxillary and mandibular incisors as a result of full-arch distalization of the dentition.

DISCUSSION

This is the first report on distalization of the entire maxillary arch by immediate relocation of mini-implants. This technique eliminates the need for patient compliance in wearing extraoral anchorage devices and is a cost-effective solution for full dental-arch distalization.

There are reports in the literature on the use of multiple mini-implants to distalize molars and retract anterior teeth. In this case report, we suggest that the entire dental arch can be more effectively distalized by planning the procedure in 2 phases: (1) distalizing the maxillary first and second molars by using mini-implants placed mesially to the maxillary first molar to achieve a Class I molar relationship, and (2) repositioning the same mini-implants between the newly distalized maxillary first and second molars to retract the anterior dental segment (premolars, canines, and incisors).

The mini-implant used for this patient's orthodontic therapy was a 2-piece temporary skeletal anchorage system with the surface treated by sand-blasting with a large grit and acid etching (SLA). The SLA surface of this mini-implant has proven to increase bone-to-implant

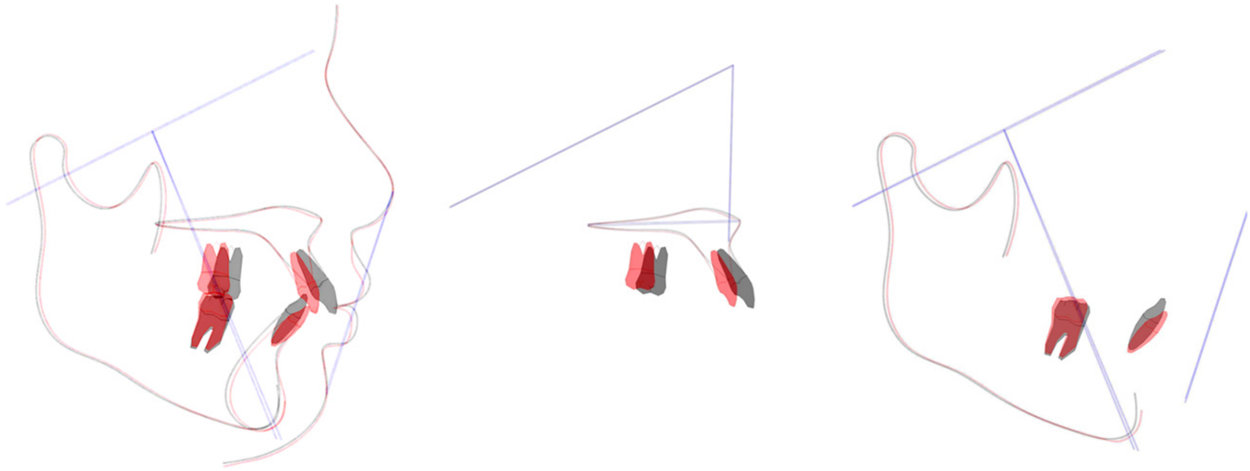

Fig 11. Superimposition of pretreatment and posttreatment tracings.

Fig 12. Intraoral retention photographs 2 years later.

contact, resulting in significantly greater stability of the mini-implant and long-term successful mini-implant retention.[18] Its 2-component assembly system (implant body and head) also allows for flexibility in choosing the size of the mini-implant head attachment to improve patient comfort and complement the necessary biomechanics for the treatment plan. In addition, the body of the mini-implant expresses blunt pitches and a dull apex, which significantly reduce the risk of root damage from the contact between the mini-implant and the root of a tooth when compared with other self-drilling and self-tapping mini-implant systems. This feature allows for a minimal amount of pilot drilling followed by manual placement of the mini-implant with a hand screwdriver.

Since there have been no clinical reports addressing the success rate of immediate repositioning of mini-implants, we cannot conclude whether the mini-implant's design (2-piece vs 1-piece) or its surface treatment properties contribute to greater success in the immediate relocation of the mini-implants. However, recent animal studies investigating the osseointegration status of reused SLA mini-implants in the same experimental subject reported that the removal torque value of the mini-implants was not significantly different from that of new mini-implants and that there

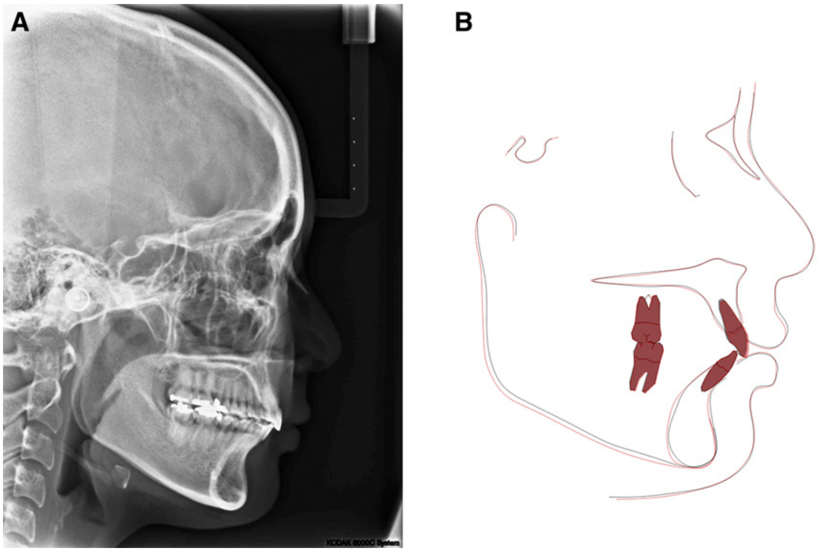

Fig 13. **A**, Two-year retention lateral cephalogram; **B**, superimposition of posttreatment and 2-year retention tracings.

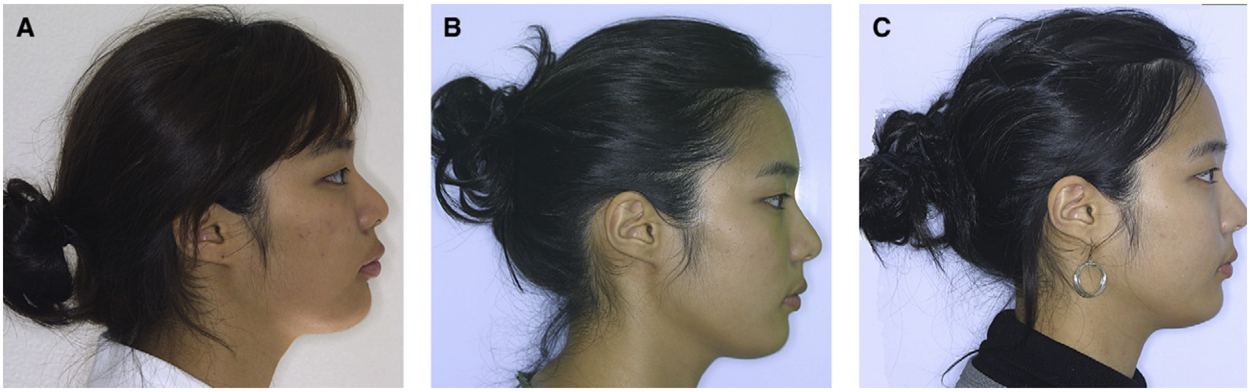

Fig 14. Profile photos: **A**, before treatment; **B,** after treatment; and **C**, 2-year retention. These show dramatic improvement in facial harmony by decreasing the upper and lower lip procumbency and increasing lower facial height.

was similar bone-like connective tissue generation at the immediate contact area of the reused mini-implant body surface.[19-21] In addition, a clinical study has shown that the placement of a new mini-implant immediately adjacent to the initially failed mini-implant site did not affect the success rate of the newly placed mini-implants, even though the same mini-implant was not reused at the new position.[22]

Although the biomechanics of immediate repositioning of mini-implants might be successful, there can still be some concerns related to immediately repositioning them in an adjacent area. First, the bone quality of the new position can be questionable in achieving optimal primary stability because of the recent bone remodeling in that area after the maxillary molar distalization (woven bone vs lamellar bone). Also, since the new position is more distal than the original mini-implant position, its placement and instrument accessibility might be more challenging for replacement. These clinical questions require further investigations. As in any mini-implant removal situation, the healing of the site where the mini-implant was removed could be another legitimate concern. Clinical observations have, however, noted that gingival healing occurred within 2 or 3 days after mini-implant removal from the initial position, and that general recovery of the area was not a major issue as long as the patient properly followed the oral hygiene instructions.

As with any surgical procedure, it is imperative to exercise the utmost care during mini-implant removal and replacement. This includes the transfer process while the mini-implant is out of the oral cavity. If the original mini-implant is dropped during the procedure, contamination issues might affect the success rate of the replaced mini-implant. In this case, a new sterile mini-implant should be used for the new site, and the original mini-implant can be autoclaved and used for the same patient in the future if additional mini-implants are needed during the orthodontic treatment.

CONCLUSIONS

This article presents a novel technique of distalizing the entire dental arch by timely relocation of SLA surface-treated mini-implants. This technique helps to reduce the cost of multiple mini-implants during orthodontic treatment and also expedites the overall treatment progress by allowing for uninterrupted en-masse retraction of the maxillary anterior teeth.

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