Correction of collapsed occlusion with degenerative joint disease focused on the mandibular arch and timely relocation of a miniplate

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This report describes a novel concept of 3-dimensional tooth movement by using biocreative therapy to provide unrestricted distal movement of the full mandibular dentition. The patient was a 26-year-old Korean woman with multiple problems, including a collapsed occlusion, a full-step Class III relationship with posterior open bite, a crossbite, temporomandibular joint pain, and a tendency for root resorption. Two orthodontic miniplates with tubes were initially placed on both retromolar pads for distalization; 1 miniplate was relocated to the anterior region for angulation and vertical control of the anterior teeth. The total treatment period was 13 months. The occlusion was finished in Class I molar and canine relationships with optimal overjet and overbite. Posttreatment records 2.5 years later showed a stable treatment outcome. The results suggest that an orthodontic miniplate is an efficient tool for the treatment of a collapsed occlusion by changing the affected arch only. (Am J Orthod Dentofacial Orthop 2012;141:e53-e63)

Patients with collapsed arches tend to have altered tooth positions; typical signs can include migration of adjacent teeth into the spaces, midline deviation, loss of vertical dimension, flaring of anterior teeth, and a multi-occlusal plane. An efficient treatment strategy essentially aims to resolve the vertical and anteroposterior problems of each segment separately while simultaneously shortening the treatment duration.

Within the last decade, the use of mini-implants as temporary skeletal anchorage devices has greatly expanded the boundaries of orthodontic tooth movement, especially for adult patients who do not want to wear extraoral appliances or undergo surgery. However, mini-implants have been associated with fairly high failure rates, including fracture during placement, loosening under loading, and root injury.1-4 Liou et al3 reported that mini-implants do not remain stationary under orthodontic forces and suggested that a safety zone for root or nerve proximity might be required. This could further restrict possible placement sites or limit the amount of tooth movement. In contrast, miniplates have an advantage because their fixation screws are generally placed apically to the roots and so do not interfere with tooth movement.5 They might provide more secure anchorage when higher forces, such as orthopedic forces, are needed. Placement of miniplates is more complex than mini-implants because flap elevation should be required by a surgeon. However, miniplates might be preferred for patients who are planned to have en-masse movement of an entire arch by more than 2 mm or extensive orthopedic corrections, or the force vectors need to be varied.5,6

Biocreative therapy (C-therapy) was developed to target the patient’s chief complaint by using a variety of temporary skeletal anchorage devices without the unwanted side effects of conventional orthodontic biomechanics.7 This treatment concept was developed
by partially osseointegrated mini-implants or plates that can easily endure multi-directional heavy forces even when they support orthodontic archwires.8-11

This case report describes the use of biocreative therapy to correct a collapsed occlusion in a patient with degenerative joint disease focused on the mandibular arch. One miniplate was relocated during treatment. This technique provided maximum treatment efficiency by reducing the cost of multiple mini-implants and the overall orthodontic treatment duration.

DIAGNOSIS AND ETOLOGY

A 26-year-old Korean woman was referred from a local clinic with a chief complaining of chewing difficulty because of her collapsed occlusion (Figs 1 and 2). She had worn an occlusal splint on the mandibular arch for 13 months, and orthodontic fixed appliances (MBT, 3M Unitek, Monrovia, Calif) were placed in the maxillary arch with 4 anterior mini-implants. Three were installed on the buccal side and 1 on the left palatal side for intrusion of the anterior teeth. The mini-implant on the right buccal side was bent because of poor placement. Initial and previous treatment records were not available. Temporomandibular joint symptoms had subsided, and no centric relation-centric occlusion discrepancy was seen at retreatment.

The patient had a straight profile and good facial proportions, but with asymmetry to the left side. The intraoral examination showed a full-step Class III malocclusion with a posterior open-bite, anterior and posterior crossbites, occlusal canting, and a deep curve of Spee. The mandibular molars were significantly inclined mesially, especially on the left side. The mandibular anterior teeth were also inclined toward the right, and the midline of the mandibular arch was shifted 4.5 mm to the right. There was occlusal contact only at the right distal end (Fig 2).

A panoramic radiograph showed root resorption of the maxillary anterior teeth and short roots in the
premolar and mandibular anterior regions. A degenerative bony change of the left condyle was found (Fig 3). Cephalometric analysis showed a skeletal Class I relationship (ANB, 0.6°) and a hypodivergent vertical pattern (FMA, 20.0°). Although the maxillary incisors had a normal labiolingual inclination (U1-FH, 116.3°), the mandibular incisors showed an excessive proclination (IMPA, 115.8°) (Fig 3, Table).

**TREATMENT OBJECTIVES**

The patient was diagnosed with skeletal Class I, dental Class III with facial asymmetry, crossbite, posterior open bite, and temporomandibular disorder. The treatment objectives were to (1) correct the molar and canine relationships to a Class I relationship, (2) achieve optimal overjet and overbite, (3) achieve a functional Class I occlusion, and (4) maintain the facial balance.

**TREATMENT ALTERNATIVES**

Based on those objectives, 2 treatment options were proposed. The ideal treatment option involved surgery to correct the skeletal asymmetry. However, the patient adamantly refused orthognathic surgery. She planned to marry in 1 year and did not want the treatment to interfere. Therefore, she accepted the second treatment option, which required the use of temporary skeletal anchorage devices (C-tube plates) to distalize the entire mandibular arch to correct the molar relationship, overjet, and overbite without involving extractions. The patient was informed that this process would include several stages: (1) upright and distalize the mandibular posterior teeth, (2) upright and retract the mandibular anterior teeth, (3) intrude the mandibular anterior teeth for vertical control, and (4) coordinate the maxillary and mandibular arches to achieve ideal overbite and overjet for the final detailing.

**TREATMENT PROGRESS**

The patient stopped wearing the splint, and 4 mini-implants in the anterior region were removed. Fixed appliances were placed in the mandibular arch with segmental approaches. The anterior (incisors and canines) and 2 posterior (premolars and molars) regions were leveled separately. Two I-type C-tube plates (Jin Biomed, Bucheon, Korea) were placed bilaterally in the retromolar area (Fig 4). Each was fixed with 2 drill-free miniscrews (diameter, 1.5 mm; length, 5 mm). The placement procedures were described in a previous article. Molar uprighting generated a significant interdental space between the canine and first premolar, which was to be used for retraction of the anterior.
dentition. After 5 months, positive overjet and overbite were achieved, and the mandibular right molars are fully distalized into a Class I molar relationship. Then the temporary skeletal anchorage device in the right retromolar area was relocated to the left anterior region to solve the occlusal plane canting caused by the overerupted mandibular left incisors (Fig 5, A-C). Relocation is a unique characteristic of C-therapy for maximum efficiency and minimum use of temporary skeletal anchorage devices. First, the miniscrews were unscrewed, and the C-tube plate on the right retromolar pad was removed. The surface of the removed C-tube plate was gently but copiously irrigated with saline solution, and it was bent along the bone contour of anterior region. The C-tube plate was reused, but the miniscrew was replaced with a new, shorter one (diameter, 1.5 mm; length, 4 mm) to prevent fatigue fracture during reimplantation into the cortical bone and adjacent root damage, although that possibility was remote.

Intrusion of the left anterior teeth and distalization of the mandibular left dentition with an omega loop mesially to the mandibular second molars serving as stops in the tip-back mechanics were continued. After 8 months, the midline was corrected, and a continuous archwire was placed in the mandibular arch (Fig 5, D-F). Concurrently, an auxiliary spring was used to upright the mandibular left molars. Finishing and detailing of the occlusion were then performed to establish a solid functional occlusion with ideal overbite and overjet (Fig 5, G-I).

**TREATMENT RESULTS**

After 13 months, debonding was performed (Figs 6 and 7). The molar and canine relationships were corrected from the full-step Class III to a Class I relationship. Also, the direction of force from the premolar to the temporary skeletal anchorage devices made the distal end rotate inward. The transverse discrepancy was simultaneously corrected to some degree but still remained.

The mandibular incisors were retracted and uprighted to coincide with the facial and maxillary midlines. In addition, the treatment resulted in an increase in facial convexity and an improvement in the lower lip profile. Facial asymmetry to the left side remained but was not aggravated during treatment.

**Figure 8 and the Table** show the posttreatment cephalometric findings. Shape changes on the left temporomandibular joint and a slight decrease of ramal height in panoramic radiograph indicated condylar remodeling. Superimposition of the pretreatment and posttreatment cephalograms showed the slightly

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**Fig 3.** Pretreatment lateral cephalogram and panoramic radiograph.
Fig 4. Treatment progress 1 month after bonding. Segmental leveling was performed. Two I-type C-tube plates were placed bilaterally in the retromolar area and immediately loaded for distalization and uprighting of the molars.

Fig 5. A-C, Treatment progress after 5 months. Surgical removal and immediate relocation of the C-tube plate in the right retromolar area to the left anterior region to correct the occlusal plane canting. D-F, Treatment progress after 7 months. Leveling of the anterior region was achieved. Distalization to the left side by using the C-tube plate was continued. G-I, Treatment progress after 10 months. The midline was corrected, and both C-tube plates were removed.
posteriorly displaced mandible. SNB was reduced by 0.7°, and pogonion moved backward 0.5 mm compared with the N-perp line, whereas the mandibular plane angle was maintained. The position of the maxilla was not changed. The interincisal angle was corrected from 104.5° to 121.2°, resulting primarily from retroclination of the mandibular incisors (impa from 115.8° to 99.3°). Mandibular superimposition showed controlled tipping of mandibular incisors and flattening of the occlusal plane primarily by molar uprighting and extrusion. The maxillary incisors were also slightly retroclined within the normal range (U1-FH from 116.3° to 112.0°). Figure 9 shows a series of occlusal photographs depicting the changes in the mandibular arch during the distalization of the posterior and anterior teeth.

Figures 10 and 11 show the stability of the occlusion 2.5 years after removal of the orthodontic appliances. In general, the dentition was stable with fixed retention from canine to canine in both arches. Correction of the occlusal and lip canting and the increased exposure of the maxillary incisors made for a more pleasant smile line. The vertical facial proportion was stable, and the asymmetry was not aggravated.

DISCUSSION

The literature contains no clinical reports addressing the success rate of immediate repositioning of temporary skeletal anchorage devices. A few animal studies reported that the removal torque value of mini-implants was not significantly different from that of new mini-implants, and that there was similar bone-like connective tissue generation at the immediate contact area of the reused mini-implant body surface. Relocation of miniplates seems to be more favorable than mini-implants because of less accumulated stress during placement or removal. Chen et al also stated that placement and removal of miniplates are minimally invasive, with mild postoperative discomfort and few risks. Instead, good adaptation of the body and connecting bar to the bone at the exit point into the oral cavity is highly recommended. The temporary skeletal anchorage device used in this patient was made of commercially pure titanium and was easily bent.
In the beginning, distalization and uprighting of the mandibular molars started in both sides with I-type C-tube plates of retromolar pads. Ideal molar angulation was achieved in the right side first. Relocation of this temporary skeletal anchorage device from the right retromolar pad to the left anterior region was done to prevent bite deepening during retraction and to control the angulation of the anterior teeth. The surgical placement was considered easy to moderately easy by the surgeons. The removal surgery was both easier and less time-consuming; the main difficulty encountered was bone overgrowth on the plates. 15,16 Cornelis et al17

Fig 7. Posttreatment study models.

Fig 8. A, Posttreatment lateral cephalogram; B, superimposition between pretreatment (solid line) and posttreatment (dotted line) tracings.
studied bone covering 25% or more of the plate reported in more than 1 in 10 patients, but it did not seem to be correlated with the location of the plate or the patient’s age. It is thus recommended that these plates be removed as soon as they are no longer needed because osseointegration increases with time.  

Although bone overgrowth complicated access to the screws, resistance of the screws themselves was not a problem. The newly placed C-tube plate was immediately loaded by using elastic thread with a force of approximately 40 g connecting the temporary skeletal anchorage device to the mandibular archwire mesial to the left canine. Most clinical relocation procedures do not require antibiotic prophylaxis and demand high levels of analgesics.

The patient had suffered temporomandibular joint pain for a long time and had degenerative changes on the left temporomandibular joint. She had been wearing a stabilization splint for 1 year before visiting our clinic, and there were no subjective symptoms. Imai et al  reported that temporomandibular disorder symptoms that have been eliminated by splint therapy are not likely to recur after subsequent orthodontic treatment, but it cannot be concluded that the orthodontic treatment itself had a positive effect on the temporomandibular disorder symptoms. Our patient decided to have no further temporomandibular joint treatment after her evaluation by a temporomandibular joint specialist. We focused on not exacerbating the discomfort of the temporomandibular joint during orthodontic treatment. No intermaxillary elastic was used during the whole treatment time, and we tried not to increase the vertical dimension of the posterior teeth when uprighting the mandibular molars. The patient was supposed to be evaluated by the temporomandibular joint specialist if the symptoms manifested again, but this did not happen. She felt more relaxed after setting the occlusion. Superimposition of the before and after treatment radiographs showed a slight backward movement of mandibular body, which might have been the result of condylar remodeling and repositioning. Shape changes and formation of the cortical outline in the left temporomandibular joint were confirmed in the panoramic radiographs (Fig 12).

Many studies have indicated that patients with a crossbite have an increased risk of developing jaw joint problems. Especially, a unilateral crossbite with displaced mandibular movement can put a strain on the jaw muscles and cause joint problems. On the other hand, subjects with Class III occlusions and bilateral crossbite rarely exhibit temporomandibular joint internal derangements or loss of vertical height of the occlusion because the mandible might not be constrained in any direction. Posterior crossbites should be evaluated based on not only the occlusal relationship of the maxillary teeth to the mandibular teeth but also the relationship to the bone, tongue,
and cheeks. Our patient was diagnosed with skeletal bilateral posterior crossbites without deviation of the jaws, and there was the same relationship in the posterior dental segments when manipulated in centric relation. To resolve the buccal crossbite, extraction of the mandibular second premolar and mesialization of the mandibular molars could have been options. However, she had spacing and severely mesially inclined molars implicating more space potentially. The time limitation and the thin periodontium also contributed to the decision for the nonextraction approach. Because we did not want to change the maxillary arch form or the angulation of the maxillary molars, we decided to finish by leaving the posterior crossbites on both sides. There were no functional problems or temporomandibular joint discomfort related to the posterior crossbite during the retention period. Carano et al stated that long-term stability in temporomandibular dysfunction patients is reached by the conversion of the posterior bilateral stops into permanent vertical stops in the finishing stage. Because our patient had firm bilateral posterior stops on both sides, it might be more functional and stable than excessive transverse camouflage treatment.

Jung and Kim reported that biomechanical considerations in treatment with temporary skeletal anchorage devices were related to 3 reference planes (sagittal, horizontal, and transverse). If a retraction force is applied via buccally positioned temporary skeletal anchorage devices, the segment will rotate around its center of rotation. However, Oh et al showed that intermolar width increased during distalization of the posterior teeth against buccal mini-implant anchorage. They used 0.017 × 0.025-in stainless steel working wires, and distal force was applied to the canines. They supposed that the intrusion force on the buccal brackets produced by the distal tipping of the canine can cause buccal uprighting of the molars and result in expansion of intermolar width. The change of molar width depends on several factors such as the location of the temporary

Fig 10. Two and a half years retention extraoral and intraoral photographs.
skeletal anchorage devices, the teeth included in the segmented arch, the size of the working wire, and the point of force application. In our patient, the 0.018 × 0.025-in stainless steel archwire was inserted sectionally from the first premolar to the end. The posterior tooth segment rotated mesially outward and distally inward by the buccally positioned miniplate related to the center of rotation in the horizontal plane. There was little play and less tipping of the mandibular first premolar. Therefore, a simultaneous decrease of mandibular molar width was achieved in spite of more posterior displacement during the uprighting period, but it was insufficient to obtain an ideal buccal overjet. The patient had root resorption of the maxillary anterior teeth. The exact cause was uncertain, but intrusion with temporary skeletal anchorage devices was

Fig 11. A, Two and a half years retention lateral cephalogram; B, superimposition between posttreatment (dotted line) and 2 and a half years retention (dot-dash line) tracings.

Fig 12. Serial panoramic radiographs: A, before treatment; B, after 5 months, with relocation of the C-tube plate completed; C, after debonding, root angulation was improved, and root resorption of the maxillary anterior teeth was not aggravated; D, 2.5 years retention.
a contributing factor before visiting our clinic. Therefore, we tried to preserve the initial state of her maxillary dentition as much as possible. First, figure-8 tying without an archwire was used, and then a passive wire was inserted later. No further root resorption was observed during the treatment period.

Reports have been made on the use of multiple mini-implants to distalize molars and retract anterior teeth. In this case study, the collapsed mandibular arch had changed occlusal plane, and problem-oriented segmental approaches were necessary to shorten the treatment time. Distalization of the mandibular premolars and molars obtained a Class I sagittal relationship, and some spaces between the canines and premolars facilitated leveling of the anterior teeth. Relocation of the orthodontic miniplate gave not only a cost benefit, but also time efficiency.

Although the biomechanics of immediate repositioning of miniplates might be successful, the relative effectiveness, efficiency, and acceptability to patients of the different temporary skeletal anchorage devices used for various clinical problems should be evaluated systematically.

CONCLUSIONS

This article presented a novel technique for distalizing and uprighting of the entire mandibular arch by timely relocation of orthodontic miniplates. This technique helps to reduce the cost of multiple mini-implants during orthodontic treatment and also expedites overall treatment progress by allowing for uninterrupted tooth movement. A multi-purpose C-tube plate also clearly figures those who want to treat a collapsed occlusion by changing the affected arch only.

REFERENCES