Protraction of mandibular second and third molars assisted by partial corticision and miniscrew anchorage

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A woman, aged 47 years 6 months, with an anterior open bite and a left-shifted mandible was treated with a mandibular right first molar extraction and without orthognathic surgery. However, her mandibular second molar did not move mesially during treatment because of the dense lamina dura; therefore, corticision was applied only on the mesial aspect of the mandibular second molar, and a miniscrew was inserted simultaneously. Corticision was introduced as a supplemental dentoalveolar surgery in orthodontic therapy to achieve accelerated tooth movement with minimal surgical intervention. In this technique, a reinforced scalpel was used as a thin chisel to separate the interproximal cortices transmucosally without a flap. This technique was applied not to accelerate tooth movement, but to protract the mandibular molars. One miniscrew was inserted on the mesiobuccal side of the mandibular right molar for protraction and intrusion. In addition, 2 miniscrews were inserted in the buccal sides of the maxillary first and second molars and the palatal side of the maxillary first molar to intrude them for correction of the mandibular shift and the cant of the occlusal plane. Excellent occlusion and correction of the anterior open bite were achieved without surgery. At the 2-year follow-up examination, the patient had a good occlusion and showed good stability with no opening of the extraction space. A partial corticision is an effective option for facilitating movement of mandibular molars. (Am J Orthod Dentofacial Orthop 2013;144:278-89)

If the third molar is present, extraction of the mandibular first molar is a possible alternative to correct an anterior crossbite and a severe Class III molar relationship. The mandibular molars are difficult to move mesially compared with the maxillary molars because the mandible comprises thick cortical bone connected by coarse trabecular bone. The molar roots are extremely wide buccolingually, so sometimes the edentulous space cannot close. Roberts et al used a rigid endosseous implant in the retromolar area for mesial movement of the mandibular molars. Recently, miniscrews, which are more convenient and simple and can be placed anywhere, have become popular for absolute anchorage. Several case reports have illustrated protraction of the mandibular second and third molars with miniscrews.

On the other hand, there are many approaches to shorten the time for orthodontic tooth movement, such as alveolar corticotomies, which produce a regional acceleratory phenomenon. This phenomenon is characterized by a burst of localized remodeling that accelerates healing, particularly after the surgical wounding of cortical bone. Kim et al reported a new procedure called “corticision” to accelerate tooth movement. This technique produces a minimal surgical injury to the gingiva, cortical bone, and trabecular bone around the target teeth, thereby initiating the regional acceleratory phenomenon.

This case report describes an orthodontic treatment with a partial corticision to protract the mandibular molars with a miniscrew for anchorage. With this technique, a reinforced scalpel was used as a thin chisel to separate the interproximal cortices transmucosally without a flap. Corticision was applied to only 1 aspect, not to accelerate tooth movement but to protract the mandibular molars.

DIAGNOSIS AND ETIOLOGY

The patient was a 47-year-old woman who complained of a maxillary anterior crossbite and a mandibular
lateral shift. Her father also had an anterior crossbite. Her face was asymmetric, and her chin and mandible were shifted to the left. Her lips were inclined, and the left corner was positioned higher than the right. On the smiling photo, her occlusal plane was canted (Fig 1). Her maxillary dental midline was almost aligned with the facial midline, but the mandibular midline was positioned 6 mm to the left because of the mandibular shift. The left side was in crossbite except for the second molars. Her anterior teeth were in an end-to-end relationship (0 mm of overbite), and she had a mild anterior open bite. She had a mandibular right third molar that occluded with the maxillary second molar. Her molar relationships were Class I on the left side and Class III (6 mm) on the right side. Overbite was 0 mm (Fig 2). Her lateral facial view showed a prominent chin and excess lower anterior facial height (Fig 1). Cephalometric analysis showed a skeletal Class III relationship (ANB, 1.0°) with a mesially positioned maxilla (SNA, 84.0°) and a forward-positioned mandible (SNB, 83.0°). The maxillary incisors were inclined labially (U1-FH, 119°), and the mandibular incisors were inclined slightly lingually (FMIA, 74.0; L1-APo, 4.5 mm) (Figs 3 and 4, Table). The soft-tissue analysis showed a slight protrusion of the lower lip (lower lip to E-line, 1.5 mm).

The panoramic radiograph showed that the roots of the mandibular right first molar were widely divergent and thick, with a dense lamina dura around the roots. The mandibular right third molar had divergent and narrow mesial and distal roots (Fig 3, C). A functional assessment showed no remarkable discrepancy between centric occlusion and centric relationship, and no temporomandibular joint problems. The mandible was shifted skeletally.

TREATMENT OBJECTIVES AND PLAN

I planned to maintain the anteroposterior position of the maxillary incisors since there was no significant facial profile problem, except for the slight protrusion of the lower lip. The main treatment objectives consisted of retracting the mandibular incisors to correct the incisor relationship and obtain a normal overbite. Midline correction consisted of reciprocal protraction of the mandibular right second and third molars and mandibular incisor retraction after extraction of the mandibular right first molar. After closure of the edentulous space, I tried to improve the canted occlusal plane with intrusion of the maxillary and mandibular right molars using miniscrews.

TREATMENT ALTERNATIVES

The first treatment of choice was to correct the skeletal discrepancies, the mandibular lateral shift, and the canted occlusal plane with a combination of orthognathic surgery and orthodontic treatment. The patient, however, was fearful of surgery and the associated risks, and rejected it. The next alternative proposal was to use temporary anchorage devices for distal movement of the mandibular right molars after extraction of the third molar to correct the anterior crossbite and the shift of the mandibular dental midline to correct the mandibular asymmetry. However, the roots of the mandibular right first molar were widely divergent and surrounded by a dense lamina dura. If possible, it was desirable to intrude the right molars to correct the mandibular shift and the canted occlusal plane during the treatment. However, the retromolar miniscrew could not be implanted deep enough to intrude the mandibular molars with distalization.

The next treatment option was an unusual extraction of only the mandibular right first premolar and reciprocal retraction of the mandibular incisors and protraction of mandibular right molars to establish a Class III molar relationship. However, with a Class III molar relationship it is difficult to establish a stable occlusion. Therefore, the mandibular right first molar was extracted, the second and third molars were protracted, and the mandibular incisors were retracted reciprocally to establish the Class I relationship between the maxillary right first molar and the mandibular right second molar.

TREATMENT PROGRESS

First, a transpalatal arch was placed for torque control of the molars and to prevent extrusion of the molars. Then the mandibular right first molar was extracted. All maxillary teeth and the mandibular right segment were banded, bonded, and leveled, and the mandibular right second premolar and second molars were moved reciprocally. Then all mandibular teeth were bonded. After 8 months of leveling, Class III elastics were worn to correct the midline deviation and the anterior crossbite. On the panoramic radiograph at this time, the radiopaque socket of the extracted mandibular first molar was observed clearly.

After 16 months, the anterior open bite was corrected, and the right canine relationship was Class I; however, the mandibular second molar did not move forward, and the mandibular right edentulous space remained at 8 mm. Therefore, I decided to apply corticision to the mesial aspect of the mandibular second molar to protract the mandibular second and third molars more efficiently. At this time, a 0.016 × 0.022-in beta-titanium wire was used as a working wire (Fig 5, A).

After local anesthesia, corticision was performed only on the mesiobuccal aspects of the mandibular second
Fig 1. Pretreatment facial and intraoral photographs.

Fig 2. Pretreatment dental casts.
molar; it was a simplified version of the original technique of Kim et al.11 A reinforced surgical blade (number15; Feather Safety Razor, Mino, Japan) was used to make a surgical incision on the cortical bone. The blade was positioned on the interradicular attached gingiva at an inclination of 90° to the molar and inserted gradually into the bone marrow under the overlying gingiva, cortical bone, and cancellous bone (Fig 5, B). The surgical injury originated at the papillary gingival margin to preserve the alveolar crest and extended 1 mm beyond the mucogingival junction because of the narrow zone of attached gingiva around the molar region. The blade was pulled out without a swing motion because of fear of injury to the lips. This procedure was modified from the original technique of Kim et al.11 They recommended pulling out the blade with a swing motion to extend the incision area. On the dental radiograph just after the partial corticision, a thick and dense lamina dura surrounded the mandibular first molar socket and inhibited mesial movement. The supra-alveolar cleft made by the incision of the scalpel was observed on the mesial side of the second molar (Fig 5, C).

Fig 3. Pretreatment radiographs.

Fig 4. Pretreatment cephalometric tracing.
At the same time, a miniscrew (8.0 mm long, 1.6 mm in diameter; Jeil Medical, Seoul, South Korea) was inserted into the interradicular attached gingiva between the canine and the first premolar. An elastomeric chain was worn from the miniscrew to the second molar for immediate protraction (Fig 5, D).

Two months after the partial corticision, the dense lamina dura of the distal root of the extracted first molar disappeared, and the second molar moved forward by 1 mm. The bone density of the mesial-cervical region of the mandibular second molar seemed less dense (Fig 6, A). Three months after the partial corticision, the second molar had moved a third of the way (Fig 6, B); 4 months later, half of the space was closed (Fig 6, C).

Four months after the partial corticision, the miniscrew loosened, the head of the screw inclined distally, and a 2-mm space appeared between the canine and the first premolar. Therefore, a new screw was reinserted 3 mm from the initial position on the apical side. Two additional screws were simultaneously inserted in the right alveolar process on both the buccal (8.0 mm long, 1.6 mm in diameter; Jeil) and palatal (6 mm long, 2.0 mm in diameter; Jeil) sides around the maxillary first molar. These 2 screws were placed to correct the canted occlusal plane by intruding the maxillary right molars. The apically repositioned mandibular miniscrew was used not only for protraction, but also to intrude the mandibular molars and improve the mandibular deviation. Three elastomeric chains were worn from each screw.

After 31 months of treatment, a good occlusion was established. Then all brackets and bands were removed,
and fixed retainers were bonded on the lingual sides of the mandibular incisors and also between the mandibular right second molar and second premolar. A circumferential retainer was used only in the maxillary arch.

**TREATMENT RESULTS**

After 2 years 7 months of treatment, a Class I ideal occlusion was obtained, and ideal overjet and overbite were also achieved (Figs 7 and 8). On the right side, the Class I molar relationship was between the maxillary first molar and the mandibular second molar. The maxillary and mandibular arches were well aligned, and the dental midlines were aligned. However, the maxillary arch was slightly skewed to obtain a normal overjet of the shifted mandible. The posttreatment facial photographs showed an acceptable balanced profile, and the facial asymmetry and the occlusal cant were improved (Fig 7).

The cephalometric analysis showed an increased SNB angle with a counterclockwise rotated mandible, whereas the SNA angle was 84.0°. The FMA was closed from 27° to 24.5°. The ANB angle decreased from 1° to 0° (Figs 9 and 10; Table). The skeletal pattern was not corrected; however, the labially inclined maxillary incisors and the lingually inclined mandibular incisors were compensated. Both maxillary and mandibular molars were intruded, and the anterior open bite and the end-to-end incisor relationship were corrected with autorotation of the mandible and no extrusion of the mandibular incisors. The mandibular incisors were retracted; this contributed to correcting the anterior open bite and obtaining a normal overjet.

On the posttreatment dental radiograph, the dense lamina dura of the extracted first molar almost disappeared, and no root resorption on the protracted second molar was observed (Fig 9, D). The posttreatment panoramic radiograph showed good root parallelism. All teeth had good alveolar bone height. The probing depths were 2.0 to 3.0 mm around the mandibular right second and third molars.

Two years after treatment, the occlusion was well maintained (Figs 11-14). Comparison of the posttreatment and 2-year retention facial and oral photos and the cephalometric superimposition showed only minor dental changes (Fig 15; Table).

**DISCUSSION**

The typical treatment for facial asymmetry with a shifted mandible and a canted occlusal plane is surgical repositioning of the maxilla and the mandible to a more normal relationship. However, this patient rejected that option, so I abandoned correcting the asymmetric facial appearance. The deviation of the dental midline and the anterior open bite were corrected orthodontically.

Previous reports have described the correction of patients with implants to intrude the posterior teeth to allow the mandible to rotate upward and forward, thus reducing the anterior face height. Therefore, I tried to correct the canted occlusal plane with intrusion of the overerupted posterior teeth using miniscrews. However, her asymmetric face could not be corrected completely.

In this patient, the unilateral mandibular first molar was extracted strategically to correct the mandibular midline deviation and the right-side Class III molar relationship. After 14 months of reciprocal traction of the anterior teeth and the second and third molars, the anterior crossbite was corrected. The canine relationship became Class I, but the second and third molars did not move mesially, and the edentulous space still remained open. The panoramic radiograph showed that the lamina dura that surrounded the extracted mandibular molar socket was still radiopaque, and the dense cortical bone of the lamina dura resisted mesial movement.

Orthodontic tooth movement resulted from the mechanical force applied to the teeth that evokes cellular responses in the teeth and their surrounding tissues, including the periodontal ligament, alveolar bone, and gingiva. In 1983, Frost demonstrated that regional noxious stimuli of sufficient magnitude can result in...
Fig 7. Posttreatment facial and intraoral photographs.

Fig 8. Posttreatment dental casts.
markedly accelerated reorganizing activity in the osseous and soft tissues. He termed this physiologic healing process the regional acceleratory phenomenon. It is characterized by a burst of the localized remodeling process, which accelerates healing, particularly after the surgical wounding of cortical bone.

Recently, many clinical trials to accelerate tooth movement have been reported with a corticotomy after flap opening.15-20 Germec et al19 showed that a single-sided partial corticotomy in the mandible appeared to be sufficient to stimulate rapid tooth movement. Surgical injury is a potentiating factor for the induction of the regional acceleratory phenomenon. For rapid canine retraction, Liou and Huang21 proposed periodontal ligament distraction. They initiated distraction just after the premolar extraction, so that their trials could be done without discomfort and complications. When I decided to use corticision, the mandibular molar had already been missing for 18 months. Therefore, I could not injure the alveolar bone without elevation of a flap.

Kim et al11 reported the new procedure, named “corticision,” and it was performed to accelerate the tooth movement. This technique also produces the regional acceleratory phenomenon. This method accelerated

Fig 9. Posttreatment radiographs.

Fig 10. Posttreatment cephalometric tracing.
Fig 11. Two-years postretention facial and intraoral photographs.

Fig 12. Two-years postretention dental casts.
tooth movement, with a minimally invasive periorthodontic procedure without flap elevation. In this case report, I have tried to be clinically expedient with a sound biologic foundation and to render the orthodontic outcome more stable and less prone to complications.

In the original technique of Kim et al,\textsuperscript{11} the corticision was performed on the mesiobuccal, distobuccal, and distopalatal aspects of a maxillary canine for canine retraction. However, it was difficult to work around the tongue, so the surgical incision was limited only on the buccal aspect. Also, the surgical blade could reach only the mesial aspect of the second molar. Furthermore, removing the scalpel with a swing motion could not be performed for fear of injuring the lips. However, a mesiobuccal surgical incision was enough stimulus for protraction of the mandibular second molar.

Previous reports stated that corticision can activate catabolic remodeling in the direction of tooth movement with less hyalinization and more rapid removal of hyalinized tissues.\textsuperscript{11} On the dental radiograph of this patient 2 months after the corticision, the cortical bone disappeared. This might have been due to the same
undermining resorption. Kim et al\textsuperscript{11} monitored the cats’ corticisions for only 28 days, but the effect of the accelerated bone resorption continued for 2 months on the follow-up dental radiographs.

In the original technique, it was suggested that the surgical injury should be 2 mm from the papillary gingival margin to preserve the alveolar crest in the cat.\textsuperscript{11} My surgical injury was performed as deep as possible. However, the patient’s lips and buccal mucosa were obstacles for the incision in the mandibular molar region. The width of the attached gingiva was not sufficient for the surgical blade, so the scalpel had to incise the oral mucosa, resulting in considerable bleeding. In addition, the marks of the scalpel were observed on the alveolar crest, but there was no alveolar bone loss near the incisive area.

It has been reported that corticision accelerated the anabolic remodeling activity as well. On day 28, the mean apposition area of the mineralized bone was 3.5-fold higher in the corticision group.\textsuperscript{11} Surely, bone apposition on the tension side was observed on the dental radiograph at the follow-up evaluations. No space appeared in the extraction area with the assistance of the fixed retainer.

Before the partial corticision, the canine relationship and the anterior incisor relationship were already corrected, so the edentulous space was closed entirely by protraction of the second and third molars. Roberts et al\textsuperscript{4,5} used endosseous implants placed in the retromolar area to close the missing first molar spaces by mesial movement of the mandibular molars. Furthermore, some articles have reported 10 mm of mesial movement of the mandibular molars with miniscrews.\textsuperscript{7-9} Therefore, a miniscrew was placed at the same time as the corticision. Four months after insertion, the miniscrew loosened and tipped distally toward the second molar side, creating a space between the canine and the first premolar.

There are many reports discussing the factors associated with the stability of miniscrews.\textsuperscript{22-24} Miyawaki et al\textsuperscript{22} concluded that immediate loading was possible if the applied force is less than 2 N. Owens et al\textsuperscript{23} concluded that the timing of force application did not influence the success rate of miniscrews, and peri-implant inflammation alone did not predispose miniscrews to failure.

However, Wu et al\textsuperscript{24} found that biomechanical stability and both maximum torque and maximum pullout
load increased with healing time, but they increased significantly only after 4 weeks. They also mentioned that miniscrew healing is a continuous process, with week 4 a critical time point. They recommended that loading is safe after 4 weeks. They reported that even after 1 week of healing, inflammatory cells, mainly macrophages, were observed on the implant-bone interfaces. In my patient, the miniscrew was placed immediately after the corticision; therefore, inflammation around the screw from the corticision might have caused the screw’s failure. I recommend that the miniscrew should be implanted at least 4 weeks before the corticision.

The miniscrew was reinserted into an apical site in thicker buccal cortical bone. Deeper positioning of the miniscrew achieved mandibular molar intrusion during the protraction. Two additional miniscrews placed buccally and palatally to the maxillary right first molar were also effective for intrusion of the maxillary right posterior segment and correction of the canted occlusal plane.

**CONCLUSIONS**

Corticision is effective for protracting mandibular second and third molars into the mandibular first molar’s edentulous space. The effect of the corticision continued for 2 months without tissue damage.

**REFERENCES**