Sequential piezocision: A novel approach to accelerated orthodontic treatment

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Piezocision-assisted orthodontic treatment is an innovative, minimally invasive surgical technique designed to help achieve rapid orthodontic tooth movement. Microsurgical interproximal openings are made in the buccal gingivae to let the piezoelectric knife create the bone injury that will lead to transient demineralization and subsequent accelerated tooth movement. When this procedure was first described, cuts were made simultaneously at the maxilla and the mandible. In recent years, the technique has evolved to a more staged approach, with selected areas or segments of the arch demineralized at different times during orthodontic treatment to help achieve specific results. The purpose of this article was to report the use of sequential piezocision in the correction of a Class III malocclusion, in a total treatment time of 8 months. (Am J Orthod Dentofacial Orthop 2013;144:879-89)

During the last decade, orthodontic innovations have changed and heightened clinicians’ and patients’ expectations. Although recent advances include appliances that are more acceptable to patients, especially to self-conscious adults, the length of orthodontic treatment is still a major concern. There have been many attempts to shorten treatment time, including rapid distraction of the canines and corticotomy-facilitated treatment. Corticotomy is an intentional injury to the cortical bone that was first described in 1892 as a surgical approach to correct malocclusion. This procedure was later modified and popularized by Kole, Suya, and Generson et al, as they referred to the “bony block” mechanical movement concept. These attempts have demonstrated that a combined corticotomy and osteotomy procedure could result in a shorter treatment time. In 2001, Wilcko et al revisited their original technique, adding bone to increase the alveolar thickness and allow tooth movement without creating dehiscences. They defined their approach as accelerated osteogenic orthodontics. They suggested that tooth movement in patients who underwent selective decortication might be due to a demineralization-remineralization process. This observation is part of a greater event that is known in the orthopedic literature as the regional acceleratory phenomenon, where a dynamic healing process occurs at the site of the osseous injury; the healing is proportional to the extent of the surgical insult. A recent publication has shown clearly that this is the mechanism. A localized surge in osteoclastic and osteoblastic activity results in a decrease in bone density and an increase in bone turnover. The regional acceleratory phenomenon begins within a few days of the surgery and usually peaks in 1 to 2 months, and then slows down and disappears as remineralization sets in.

Although effective and highly predictable, corticotomy-assisted orthodontic treatment is quite invasive because it requires extensive flap elevation and osseous surgery, which can cause postsurgical discomfort as well as various postoperative complications. Vercellotti and Podesta proposed the use of a piezoelectric knife instead of a high-speed surgical bur to decrease the surgical trauma and still achieve rapid tooth movement. Because of its micrometric and selective cut, a piezoelectric device produces safe and precise osteotomies without osteonecrotic damage. In 2009, Kim et al introduced the corticision technique as a minimally invasive alternative to create a surgical injury to the bone without flap reflection. In this technique, they used a reinforced scalpel and a mallet to go through the gingiva and cortical bone, without raising flaps. This surgical injury was deemed
enough to induce the regional acceleratory phenomenon and move the teeth rapidly during orthodontic treatment. This technique, although innovative, has a few major drawbacks: the inability to graft soft or hard tissues during the procedure to correct inadequacies and reinforce the periodontium, and transient postsurgical dizziness from the repeated malleting during the surgery. In 2009, we proposed a new and minimally invasive procedure that we called “piezocision.”16 This approach combines microincisions to the buccal gingivae that allow for the use of the piezoelectric knife to decorticate the alveolar bone to initiate the regional acceleratory phenomenon. Although it is minimally invasive, it also has the advantage of allowing for hard-tissue or soft-tissue grafting via selective tunneling to correct gingival recessions or bone deficiencies in patients.17

When this procedure was first described, the piezocision cuts were made simultaneously in both arches to correct the malocclusion.16-18 In this case report, we present a new application of piezocision-assisted orthodontic treatment. Sequential piezocision is introduced as a tool to correct a Class III malocclusion in a total treatment time of 8 months.

DIAGNOSIS AND ETIOLOGY

A 25-year-old woman sought orthodontic treatment with chief complaints of misaligned teeth and an unfavorable smile. Her medical and family histories were not contributory. She had a slightly concave profile with a prominent nose and chin (Fig 1).

The intraoral examination showed that she had healthy periodontal tissues and good oral hygiene. Her maxilla was constricted. Her maxillary right second premolar, maxillary right canine, right and left lateral incisors, and maxillary left central incisor were in crossbite. She exhibited a Class III malocclusion with a narrow maxilla (Fig 2). The space analysis done on the study models showed 7.5 mm of crowding in the maxillary arch and 2 mm of crowding in the mandibular arch. The radiographic evaluation showed no visible pathologies (Figs 3 and 4). She had composite fillings on the maxillary central incisors, maxillary left lateral incisor, and mandibular first molars.

The cephalometric analysis showed a skeletal Class III pattern with an ANB angle of −1.2° and a Wits value of −9 mm (Table). The SNB value was in the normal range (78.4°), showing that the slight Class III pattern was due to the retracted position of the maxilla (SNA, 77.2°). IMPA and the angle axis of L1 to NB showed that the mandibular incisors were upright.

TREATMENT OBJECTIVES

The treatment objectives for this patient were to correct the crossbites, resolve the crowding in the maxillary and mandibular arches, and achieve Class I molar and canine relationships. Ideal overjet and overbite relationships were also desirable to improve the occlusion and for anterior and lateral guidance. Other treatment objectives were to correct the incisor positions, maintain upper lip support for satisfactory facial harmony, and achieve favorable smile esthetics and profile.

TREATMENT ALTERNATIVES

Three treatment alternatives were presented to the patient.

One alternative included extraction of the maxillary first premolars to resolve the crowding and align the maxillary arch, and maxillary advancement surgery to correct the malocclusion and the profile. This option would correct the dental problems and significantly improve the facial
The patient was not willing to have orthognathic surgery under any circumstances and expressed that her primary concern was not to correct her facial appearance. Therefore, the surgical option was excluded.

Since the patient refused to have orthognathic surgery, extractions in the maxilla would create a more prominent Class III pattern; hence, the option of extractions to correct the crowding was eliminated.

Another alternative involved using surgically assisted rapid palatal expansion to create space to align the maxillary teeth and intermaxillary elastics to correct the malocclusion.

When the patient expressed her concern regarding treatment time, a third option was presented. This option would use piezocision to shorten the treatment time and also to create a more pliable bone structure to expand the maxillary arch. The amount of crowding in the maxillary arch was more than what could be resolved with expansion alone; therefore, interproximal reductions, especially on the teeth with the composite fillings, were also planned. Because the amount of correction needed in the maxilla was more significant than that in the mandible, a different therapeutic approach, concomitant with the piezocisions, was devised. The piezocisions were planned in a sequential manner, starting with the maxillary arch; after correction of the crossbites, the mandibular arch would be bonded and the mandibular piezocisions performed. The total treatment time for this option was estimated to be less than 1 year. The patient, refusing the orthognathic surgical treatment, decided to undergo piezocisions in conjunction with nonextraction treatment.

Rhinoplasty was also mentioned as another esthetic intervention to complement her profile at the end of the treatment.

**TREATMENT PROGRESS**

Treatment was started by bonding the maxillary arch only, from second molar to second molar but excluding the maxillary left lateral incisor because of the lack of space. A 0.014-in nickel-titanium alloy archwire was placed; bite-rising cones were placed on the mandibular
molars to open the bite and create the interocclusal space for the crossbite corrections.

Piezocisions on the maxillary arch were done 9 days after the initial bracket placement. Local anesthesia was given, and 6 vertical interproximal incisions were made with a blade below the interdental papilla on the buccal aspect of the maxilla mesial to the first molars, and mesial and distal to the canines. These incisions were minimal, just to give access to the piezosurgical knife (Satelec; Acteon Group, Merignac, France), which was then used to create the alveolar decortication through the gingival opening to a depth of approximately 3 mm (Fig 5). A prescription for a nonsteroidal anti-inflammatory drug was given, and the patient was advised to rinse twice a day with chlorhexidine for a week. Because of the rapid and temporary demineralization that occurs after piezocision as a result of the regional acceleratory phenomenon effect, the orthodontic appointments were scheduled every 2 weeks instead of every 4 weeks. The wire sizes progressed from 0.014-in nickel-titanium alloy to 0.016 × 0.022-in nickel-titanium alloy archwires for leveling and alignment. Once the crossbites were corrected, the bite opening cones on the mandibular molars were removed. Two and a half months after the maxillary piezocision, the mandible was bonded, and a 0.016-in nickel-titanium alloy archwire was placed. Piezocisions on the mandible were done 2 weeks later. Six vertical interproximal incisions were made in the same manner as described for the maxilla (Fig 6). The archwires progressed from 0.016-in nickel-titanium alloy to 0.016 × 0.022-in stainless steel for leveling and alignment. Class III elastics were used to correct the Class III relationship. The orthodontic treatment was completed in 8 months. Fixed retainers were placed in both arches, and Hawley plates were given for retention.

**TREATMENT RESULTS**

At the end of the orthodontic treatment, Class I canine and molar relationships were established. Maxillary and mandibular crowding was resolved, ideal overjet and overbite were achieved, and the crossbites were
corrected (Figs 7 and 8). The severe crowding in the maxilla was resolved by expanding the maxillary arch and performing interproximal reductions; mandibular crowding was resolved by interproximal reductions alone. There were no scars at the sites of the piezocision cuts. A major space problem in the maxillary arch was easily solved after the piezocisions by expansion and interproximal reductions because of the more pliable bone created by the piezocuts. Once the space issue was resolved and the maxillary dentition was aligned, it was easier to control the bite and achieve a Class I canine and molar relationship; hence the reason for bonding the mandibular dentition after the maxillary alignment. The improvement of the profile was significant. No pathology or root resorption was detected on the posttreatment radiographs (Figs 9 and 10).

The posttreatment cephalometric analysis showed no major changes compared with the initial values (Table). The interincisal angle decreased from an initial value of $135^\degree$ to a final value of $130^\degree$ because of the proclination of the maxillary incisors at the end of the treatment. A slight increase of the FMA angle was observed because of the extrusive nature of the mechanics and intermaxillary elastics used (Fig 11). Although a favorable smile was created and the patient was happy with the result and the speed of the treatment, we noticed that better palatal crown torque could have been given to the maxillary left lateral incisor (Fig 7).

The mandibular first molars had extensive restorations with inadequate tooth forms and anatomies; therefore, the patient was referred to her general dentist for retreatment of these teeth.

At 18 months posttreatment, the profile correction appeared to be stable, and the maxillary expansion and maxillary and mandibular arch forms remained stable (Fig 12). Although there was some relapse on the right side, the canine relationship was Class I. The patient did not have her mandibular first molars retreated during the 18 months after the orthodontic treatment. No root resorptions or pathologies were detected on the 18-month posttreatment radiographs (Figs 13 and 14). A small relapse can be seen on the mandibular superimpositions of the posttreatment and 18-month posttreatment tracings (Fig 15). However, the maxillary teeth remained stable.

**DISCUSSION**

A Class III malocclusion with a skeletal component is an orthodontic challenge, especially when a conservative approach is requested. An important factor for the successful treatment of this malocclusion is the facial growth pattern. A reduced lower anterior face height, deep overbite, and passive lip seal, associated with a Class III malocclusion, have a better prognosis, because treatment-induced backward rotation of the mandible will assist in camouflaging the anteroposterior discrepancy. When an increased lower anterior face height is associated with this malocclusion, surgical intervention is the treatment of choice, because any orthodontically induced mandibular clockwise rotation will increase the vertical facial dimensions and, consequently, cause lip incompetence. For patients reluctant to undergo surgery or who are satisfied with their facial...
appearance, an alternative is to treat with dentoalveolar compensation without correcting the underlying skeletal deformity. Since our patient refused surgery, the treatment approach was dentoalveolar compensation. A major advantage was the decreased vertical dimension, and this made the patient a good candidate for dentoalveolar compensation. Class III elastics were used to camouflage the anteroposterior discrepancy. Patient compliance in using the Class III elastics was crucial for success, and she was compliant with the elastic wear. We achieved the Class III correction with intermaxillary elastics. The effects of Class III elastics caused a small maxillary protrusion, and the mandible displayed a small retrusion, probably consequent to the backward and downward rotation that this apical base experiences when Class III elastics are used.20-22 These changes in the apical anteroposterior position contributed to the improvement in their relationship. The maxillary incisors were labially tipped, and the mandibular incisors were lingually tipped. The vertical component of the elastics produced small extrusions of the maxillary molars and mandibular incisors (Table, Fig 11).

Evidently, an orthodontic-surgical approach could have produced greater skeletal correction of the Class III discrepancy, but the treatment should aim to solve the patient’s primary concerns.23-25

This patient had a significant amount of maxillary crowding, with anterior crossbites and a Class III malocclusion. Since she refused orthognathic surgery, extractions in the maxilla were not an option because that would have made nonsurgical correction impossible. In nonextraction treatment modalities, the resolution of crowding is usually achieved by distal movement of the posterior teeth, advancement of the anterior teeth, interproximal reduction, and transversal expansion.26 Interproximal enamel reduction (stripping) removes controlled amounts of proximal enamel without

Fig 7. Posttreatment extraoral and intraoral photographs.
damaging the teeth. This procedure, extensively investigated by many researchers, has undergone various technological developments and become a widely used clinical technique. Although stripping was introduced as an adjunctive treatment to resolve anterior crowding, Sheridan proposed its use in both the posterior and anterior segments to resolve crowding up to 10 mm. Thus, interproximal enamel reduction might be an alternative treatment approach for space-gaining procedures such as arch expansion, distalization of the molars, protrusion of the incisors, and extractions in some patients with moderate crowding and balanced profiles. However, the limitations (thin enamel and reduced proximal convexity) and complications (risk of tooth sensitivity) of interproximal enamel reduction should also be considered, because this is an irreversible procedure. Therefore, interproximal enamel reduction should be used carefully with respect to the anatomy and physiology of the teeth. Another concern about stripping is the long-term health of the teeth. A follow-up study showed that interdental enamel reduction in the mandibular anterior region did not lead to dental caries, gingival recession, or alveolar bone loss over 10 years. In this patient, crowding was resolved by a combination of expansion and interproximal stripping. The
patient had composite fillings especially on the mesial and distal aspects of her anterior teeth; therefore, interproximal enamel reduction was done mostly from the fillings, creating no damage or adverse effects for the long-term health of the teeth.

A recently described, minimally invasive surgical technique (piezocision) is a novel tool in the armamentarium of the treating dental team. Piezocision-assisted orthodontic treatment speeds up the treatment and increases the scope of tooth movement. This technique also allows the placement of hard-tissue and soft-tissue grafts in case of preexisting bony dehiscences, fenestrations, thin buccal alveolar bones, or mucogingival defects. The concept is to access the alveolar buccal bone through microsurgical interproximal openings in the gingivae and use the demineralization properties of the piezoelectric knife to create the injury to the bone that will start the regional acceleratory phenomenon effect. When the bone is injured, a dynamic healing process occurs at the site of the injury that is proportional to the extent of the surgical insult. The regional acceleratory phenomenon effect can start as early as 24 hours (data not shown), usually peaks in 1 to 2 months, and then slows down and disappears as remineralization sets in.

This dynamic process with its burst of local activity (bone remodeling, surges in osteoclastic and osteoblastic activity) creates a transient osteopenia responsible for the rapid tooth movement because the teeth are moving in a more “pliable” environment. The judicious use of the localized demineralization process to achieve a positive orthodontic outcome in a minimally invasive manner is the essence of piezocision. We are, in essence, using (and perhaps guiding) the physiologic response of the body to local injury to help the dental team and the patient achieve their therapeutic goals. In recent years, the technique has evolved from being used throughout the whole mouth in 1 surgical setting approximately 1 week after the initial bracket placement or the application of the orthodontic force to a staged approach, with selected areas or segments of the arch demineralized at different times during orthodontic treatment to help achieve specific results. We called this approach segmental or sequential piezocision. This case report illustrates the sequential approach. The patient had severe maxillary crowding that required more tooth movement to correct the malocclusion, compared with the mandible. She also had multiple crossbites caused by the skeletal discrepancy. Bonding both arches at the same time would have created some buccal movement of the mandibular incisors, making it hard to control the overbite and correct the crossbites. Since piezocision creates a more pliable bone, the effects of a nickel-titanium wire become exaggerated. Subsequently, the decreased resistance created by the piezocision effect allows for faster buccal movement of the mandibular incisors; this compromises the control of the overbite, especially in patients with anterior crossbites. For this reason, the maxillary teeth were bonded initially, piezocision was done in the maxillary arch, crowding was resolved, and the crossbites were...
corrected. A rectangular stainless steel wire was placed on the maxilla with simultaneous bonding of the mandibular arch. This was done 2.5 months after the maxillary piezocisions, when the regional acceleratory phenomenon effect was at its peak, enhancing and complementing the effects of the Class III elastics in the maxilla.

In retrospect, the posterior alignment might have been better if the second and third molars had been banded or bracketed; also, a better palatal crown torque

**Fig 12.** Posttreatment extraoral and intraoral photographs at 18 months.

**Fig 13.** Posttreatment panoramic radiograph at 18 months.

**Fig 14.** Posttreatment cephalometric radiograph at 18 months.

In retrospect, the posterior alignment might have been better if the second and third molars had been banded or bracketed; also, a better palatal crown torque
could have been given to the maxillary left lateral incisor (Fig 7).

At 18 months posttreatment, a small relapse can be seen on the superimposed mandibular tracings (Fig 15). However, the maxillary teeth remained stable. The small relapse might have been prevented by keeping the patient in heavy wires for another 3 months after the Class I relationship was achieved. Total treatment time in fixed appliances has always been a major concern for adult patients. Accelerating the orthodontic treatment is a major benefit for them. The active treatment time was 8 months for our patient, but it might have been more stable if active retention was used and the fixed appliances were removed after stabilizing for a few more months. Even in that case, the overall treatment time would still be much shorter because of the use of piezocision.

Another compounding factor for the relapse was the less than ideal occlusal anatomy of the posterior teeth leading to poor intercuspation and poor stability. The patient was referred to her general dentist to address the restorations of the posterior teeth, but she did not have that treatment.

Because this patient’s concern was primarily her dental and smile esthetics, we obtained the most from the orthodontic mechanics available to satisfy her needs without orthognathic surgery. This case is unique in that piezocision was used to assist and guide the orthodontic mechanics in a sequential manner, enhancing their affects and significantly decreasing the treatment time.

CONCLUSIONS

Piezocision is an innovative, minimally invasive technique designed to achieve rapid orthodontic tooth movement without the downside of extensive and traumatic conventional surgical approaches. This new technique can be combined with various orthodontic treatment modalities to satisfy today’s adult patient population, and modifications can be made to meet the specific mechanical requirements. This case report illustrates how piezocision can be used sequentially in selected patients to produce outcomes that are both timely and satisfactory.

REFERENCES