Effect of piezocision on root resorption associated with orthodontic force: A microcomputed tomography study

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Introduction: The purpose of this study was to investigate the effect of piezocision on orthodontically induced inflammatory root resorption. **Methods:** Fourteen patients were included in this split-mouth study; 1 side was assigned to piezocision, and the other side served as the control. Vertical corticotomy cuts of 4 to 5 mm in length were performed on either side of each piezocision premolar, and 150-g buccal tipping forces were applied to the premolars. After 4 weeks, the maxillary first premolars were extracted and scanned with microcomputed tomography. **Results:** There was a significantly greater total amount of root resorption seen on the piezocision sides when compared with the control sides ($P = 0.029$). The piezocision procedure resulted in a 44% average increase in root resorption. In 5 patients, there was noticeable piezocision-related iatrogenic root damage. When that was combined with the orthodontic root resorption found on the piezocision-treated teeth, there was a statistically significant 110% average increase in volumetric root loss when compared with the control side ($P = 0.005$). **Conclusions:** The piezocision procedure that initiates the regional acceleratory phenomenon may increase the iatrogenic root resorption when used in conjunction with orthodontic forces. Piezocision applied close to the roots may cause iatrogenic damage to the neighboring roots and should be used carefully. (Am J Orthod Dentofacial Orthop 2017;151:53-62)

Orthodontically induced inflammatory root resorption[1] is defined as the loss of dental hard tissues caused by clastic cellular activity.[2] It is an undesirable and often unpredictable side effect of orthodontic tooth movement,[3,4] with a complex and multifactorial etiology.[5]

Orthodontic tooth movement relies on the complicated changes that occur in the periodontal ligament, supporting alveolar bone, and tissues with differing cell populations and differing remodeling capabilities.[6] During tooth movement, the production of hyalinization regions in the periodontal tissues occurs particularly upon the application of heavy forces.[7,8] The removal of these hyalinization zones by osteoclasts has been associated with orthodontic root resorption.[9,10]

Corticotomies have been discussed in the orthodontic literature as a means for accelerating the rate of tooth movement for over 100 years.[11] Initially, it was believed that corticotomies accelerated tooth movement because of segmentation of alveolar bone and the en-masse movement of the teeth and associated block of bone. More recent research has used corticotomies as a means of accelerating the rate of bone turnover.[11-13] Corticotomy accelerates orthodontic tooth movement via the activation of a regional acceleratory phenomenon (RAP).[14-16] The RAP effect usually commences within a few days of injury, peaks at 1 to 2 months, and lasts for 2 to 4 months, with up to 6 to 24 months reported in the literature.[11,17-19] This normal healing process involves the acceleration of growth, remodeling, metabolism, healing, inflammation, perfusion, cell turnover, and repair of microdamage.[20,21]

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The corticotomy-induced RAP response accelerates tooth movement by producing temporary demineralization/osteopenia in the bone surrounding the roots of activated teeth. These teeth that have been activated by corticotomies experience more rapid and extensive alveolar bone and periodontal ligament turnover.[22] The literature has demonstrated that corticotomies can increase the rate of orthodontic tooth movement by up to 2 to 3 times the normal rate.[23,24]

There is only limited evidence in the orthodontic literature that demonstrates a statistically significant reduction in the amount of root resorption with the use of corticotomy procedures, when compared with normal tooth movement.[25,26]

Piezocision is a more conservative and less invasive variation of the traditional corticotomy technique.[12,27,28] It involves the use of an ultrasonic cutting instrument to make the corticotomy incisions, without the need for raising a soft tissue flap. It has been claimed that piezocision can produce comparable rates of accelerated tooth movement to more conventional corticotomy procedures.[12]

The aim of this pilot study was to investigate the effect of piezocision on root resorption when 150-g buccal tipping forces were applied to maxillary first premolars for a 4-week period. A qualitative and quantitative assessment of the degree of root resorption was performed by microcomputed tomography scanning of the extracted premolars.

MATERIAL AND METHODS

The sample consisted of 28 maxillary first premolars that were extracted bilaterally from 14 patients. There were 6 male and 8 female patients (mean age, 16 years 2 months; range, 13 years 1 month to 19 years 0 month). They required the extraction of maxillary first premolars as part of their orthodontic treatment. Ethics approval was granted by the Sydney Local Health District, RPAH Zone (ethics approval numbers X13-0371 and HREC/13/RPAH/519). The patients were carefully selected according to previously described strict inclusion criteria, and written informed consent was obtained.[29]

After the collection of pretreatment records, the subjects had a baseline periodontal checkup for standardized periodontal measurements and oral hygiene control before the experiment.

Using a split-mouth study design, we allocated the maxillary first premolars to 1 of 2 groups for each participant. One side was chosen to have the piezocision procedure performed, with the other side acting as the control. In some participants, it was apparent that there was limited interradicular space between the maxillary first premolar and canine or second premolar. There was concern that randomization might result in iatrogenic damage to the teeth when performing the piezocision procedure, so the side with the least risk of causing root damage was selected.

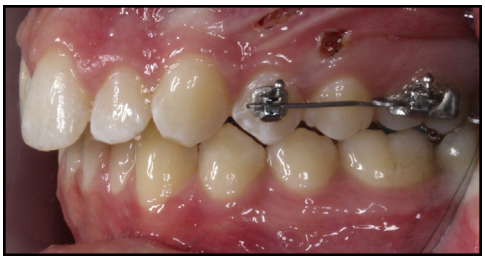

Fig 1. Appliance design with 0.017 × 0.025-in beta-titanium alloy buccal tipping springs.

The subjects had partial fixed appliances placed on the maxillary first premolars and first molars bilaterally. Self-ligating 0.022-in SPEED brackets and tubes were used (Strite Industries, Cambridge, Ontario, Canada). Buccal tipping forces (150 g) were applied to the maxillary first premolars by 0.017 × 0.025 Beta III Titanium (3M Unitek, Monrovia, Calif) cantilever springs. The springs were inserted into the maxillary first molar and first premolar brackets and bypassed the maxillary second premolar (Fig 1).

The force produced by the springs was calibrated with a strain gauge (Dentaurum, Ispringen, Germany) and customized to each premolar. Once the springs were fitting well and generating 150 g of force, they were taken out of the brackets to allow unimpeded access to the surgical site. In addition, occlusal stops (Transbond Plus Light Cure Band Adhesive; 3M Unitek) were placed onto the mesiopalatal cusps of the maxillary first molars to prevent occlusal interferences and allow uninhibited tipping of the maxillary first premolars during the experiment.

At the same appointment, the piezocision procedure was performed on 1 maxillary first premolar. A surgical setup was used for all subjects, with a sterile field of operation. Local anesthetic was administered (Lignospan lidocaine hydrochloride 2%, 1:100,000 Adr; Septodont, France), and then a soft tissue laser (Picasso; AMD Lasers, Indianapolis, Ind) was used to produce 2 buccal vertical interproximal incisions into the gingiva/mucosa, one on the mesial side and one on the distal side of the first premolar. The incisions were made apical to the interdental papilla, 5 to 7 mm long. A piezocision blade (VarioSurg Ultrasonic Bone Surgery System; NSK-Nakanishi, Tochigi, Japan) was then inserted into the soft tissue incision, as per the technique of Dibart et al[12] and Dibart and Dibart.[27] The piezocision blade