Effect of flapless piezopuncture on maxillary canine distalization. A preliminary randomized controlled trial

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ABSTRACT

Several methods have been described to shorten orthodontic treatments, but the main disadvantage is their invasiveness. Animal studies have shown that piezopuncture can accelerate the rate of tooth movement without causing collateral damage. Objective: To evaluate the clinical outcome, in terms of safety and efficacy, of a flapless piezopuncture on maxillary canine distalization. Methods: A split-mouth randomized clinical trial was carried out on five patients. Piezopuncture was performed on a random side of the maxillary arch to assess the rate of canine movement on the stimulated side, compared to the non-stimulated control side after 15 (T1), 30 (T2), and 60 (T3) days. Also, immediate side effects and changes in buccal bone thickness after one year were assessed. Results: Distalization on the intervention versus control side at T1 was 1.24±0.21mm versus 0.64±0.33mm (p=0.005); at T2 it was 2.00±0.28mm versus 1.36±0.49mm (p=0.046); and at T3 it was 4.28±0.66mm versus 3.65±0.88mm (p=0.102). No adverse effects related to the surgical procedure were observed or reported by patients. The thickness of the buccal bone plate showed no significant changes. Conclusions: Flapless piezopuncture accelerates the rate of tooth movement in orthodontic patients over the first 15 days and its effect declines over the next 45 days.

KEY WORDS

Tooth movement; Distalization; Rapid orthodontics; Piezosurgery; Minimally invasive, Surgical procedures.

INTRODUCTION

One of the major challenges facing orthodontists and patients is to reduce treatment length1-3. Several methods have been described to shorten orthodontic treatments and thus avoid their potential side effects. Surgically assisted techniques have shown predictable results4-6, causing reversible bone injury and providing a period of less resistance to tooth movement, known as the Regional Acceleratory Phenomenon (RAP)7-9. However, the main disadvantage of these techniques is their invasiveness. In the search for less invasive procedures, corticision and piezocision have been proposed as alternatives. Corticision is performed by malleting the cortical bone with a reinforced scalpel10-12. Piezocision is performed using a piezoelectric saw13. Although these two procedures avoid the extensive trauma of earlier techniques, significant drawbacks are restricting their use. Corticision causes discomfort and dizziness in patients due to repeated malleting. Piezocision requires tunnelization for bone grafting, which makes the procedure somewhat complicated, there are no landmarks to avoid tooth damage13 and even when improvements have been described, using surgical guides8-10 the risk of residual scars remains and this could limit its indication11. The use of piezocision in orthodontics remains uncertain since current evidence is weak and studies are short term12-13.

Micro-osteo perforation has also been reported as a minimally invasive procedure for accelerating tooth movement by enhancing the cellular response14. However, this technique requires the use of orthodontic mini-screws or a device called Propel, which design limits access in the posterior area of the mouth. Moreover, this instrument needs to be applied mini-screws or a device called Propel, which design limits access in the posterior area of the mouth. Moreover, this instrument needs to be applied...
random numbers (Research Randomizer Software, Geoffrey C. Urbaniaik & Scott Plous, USA) with a 1:1 allocation ratio to assign the side of the maxillary arch that would receive the intervention.

The allocation sequence was concealed using sequentially numbered, opaque, sealed envelopes containing the group (piezopuncture group or control group) to which each side should be assigned. These envelopes were opened by the surgeon just before surgery to ensure concealment of the randomization list.

Blinding of personnel and participants was not applicable due to the nature of the intervention. Therefore, blinding was applied only to the outcomes’ assessor.

**Intervention protocol**

Three weeks after bilateral extractions, piezopuncture was performed at a random side of the maxillary arch. All piezopunctures were performed under local anesthesia (Octocaine 2%), by a single surgeon, using a sharp, curved ultrasonic tip (PROOrthodonticsTM, BROKTM, LLC) (fig. 1) connected to a piezoelectric handpiece (Mectron, Carrasco, Italy). The device was configured to Bone Quality 1 (the strongest of the three settings) and the tip was perpendicularly applied to the gingiva, in the interproximal spaces. With gentle pressure and under saline-solution irrigation, the tip punctured the bone through the gingiva to a depth of approximately 1 mm, in less than one second. In all cases, four piezopunctures were made mesial and distal on the buccal side of incisors and canine of the intervention side of the arch (fig. 2). Before and after surgery, the patient rinsed with chlorhexidine gluconate 0.12% for 30 seconds.

Immediately after piezopuncture, a 0.014” nickel-titanium alloy archwire was placed on both arches. Rematitan lite extension springs of 12 mm with forces of 150 g were placed between the canines and first molars. Force was measured with a tension gauge. For home care, the patient was instructed to gently brush the teeth in the adjacent surgical sites and rinse with chlorhexidine gluconate 0.12% twice a day for 3 days. No nonsteroidal anti-inflammatory drug was prescribed after the intervention. Appointments were scheduled at 15, 30 and 60 days after the procedure.

**Outcomes**

The primary efficacy endpoint was the canine distalization per side at day 15 (T1), 30 (T2), and 60 (T3), measured in mm. Progress in canine movement was assessed by tracking canine distalization from baseline, comparing the intervention and the control side (Fig. 3, Fig. 4).

Maxillary stone models of each patient were taken at baseline, 15, 30 and 60 days. Standardized photographs perpendicular to the occlusal plane were taken of the stone models, and by using computer software Dolphin Di3D v.11.8 (Dolphin Imaging; Chatsworth, CA), the middle raphe line was drawn up to the incisive papilla and a perpendicular line was traced from the center of the cingulum of each canine (fig. 5), as previously described(19).
The distance from the incisive papilla to the intersection of the right and left canine line was recorded at baseline, T1, T2 and T3 by a single operator, who was blinded to the randomized intervention side.

The secondary efficacy endpoint was the preservation of the buccal bone wall after piezopuncture on both sides of the jaw, assessed by measuring the buccal bone plate of each anterior tooth at 5 mm from the cement–enamel junction, before intervention and one year after treatment, by means of cone-beam computed tomography.

The safety endpoint was the frequency of adverse effects related to the surgical procedure (e.g., infection, root damage, tissue necrosis), and was assessed by clinical observation at each appointment, with the exception of root damage, which was evaluated on CBCT after one year.

**Statistical analysis**

The statistical analysis was carried out using STATA 12/SE (Stata Corp., USA). A paired two-sample mean-comparison t-test was used to evaluate the difference between the intervention and control group at T1, T2 and T3. Statistical significance was considered at p<0.05.

**RESULTS**

Five patients were enrolled in the trial, and their demographic and clinical characteristics are shown in table 1. Patient allocation and follow up is shown in figure 6; one patient was missed at T3.

A comparison of canine distalization between the control and intervention group is shown in table 2.

The thickness of the buccal bone plate of the anterior teeth in all patients showed no significant changes after 12 months of treatment (fig. 7).

No adverse effects related to the surgical procedure were observed or reported by patients.

**DISCUSSION**

In the five patients, canine movement was accelerated in the intervention side compared to the control side. During the first two weeks, movement of the canine on the intervention side was on average 2-fold faster than on the control side; this velocity decreased by the second half of the first month, and in the second month.

The above is due to the transitory RAP, activated by the surgical micro-trauma, which appears to be more effective, in terms of velocity, during the first two weeks after stimulation. These findings are consistent with a recent animal study by Van Gemert et al. (20), in which the effect of micro-trauma was evident between the 2nd and 4th week after intervention, and also with other techniques reported in the literature to reduce the duration of orthodontic treatment (4,7,21,22).

A recent publication by Charavet et al. (23) concluded that current literature on minimally invasive corticotomy techniques supports their role as therapeutic tools in the acceleration of orthodontic tooth movement (OTM). Furthermore, a recent systematic review on the effects of piezocision in OTM found that the majority of studies recorded a significant acceleration in OTM, but concluded that literature does not provide high-quality evidence to confirm the results. Moreover, such acceleration implies around 1 mm of OTM as measured after 4 to 12 weeks; and there are some drawbacks that might limit its indication, such as tooth damage (8), the need for surgical guides (9,10) and the risk of residuals scars (11).

No side effects were observed in this study, and no root resorption was detected after one year of treatment, when pre- and postoperative CBCT were compared. The resorption rate of the buccal bone plate was within the normal limits of conventional orthodontic treatment, which is −0.56 ± 0.7 mm (24).

Considering the atraumatic nature of piezopuncture technique, its transitory RAP and the absence of clinical complications, future research is needed to further investigate its potential in orthodontic treatment.
could consider the use of flapless piezopuncture applications every 8 to 12 weeks in order to boost its effect. In this regard, more research is needed to assess the effects of this technique in other clinical situations that demand rapid OTM.

This preliminary trial followed a strict methodology and reporting, but some limitations are acknowledged. Canine distalization over the first 60 days and clinical complications were the only outcomes assessed, excluding other relevant variables such as treatment duration, but it is known that the time required to complete an orthodontic treatment is influenced by a large number of factors, which could act as potential confounders.

This study provides preliminary evidence on the effect of flapless piezopuncture to accelerate the rate of tooth movement in orthodontic patients but larger studies are necessary to determine the effects of this novel technique.

CONCLUSIONS
Flapless piezopuncture performed using a sharp ultrasonic tool accelerates the rate of tooth movement in orthodontic patients over the first 15 days and its effects decline over the next 45 days.

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INTEREST CONFLICT:
Jorge Jofré is CEO of BROKSPA that manufactured PROOrthodontics™. Other authors declare that they have no conflict of interest. The authors are responsible for the content and writing of this paper.

References