Comparative Evaluation of Speed of Orthodontic Tooth Movement with or without Piezocision Technique: An *In vivo* Study

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Abstract

Background: Last decade has seen a surge of many innovative techniques aimed at decreasing the length of orthodontic treatment. In this study, the efficiency of canine retraction between piezocision and conventional retraction group has been evaluated and compared. **Materials and Methods:** A total of ten patients (above 18 years) with Class II division I malocclusion or bimaxillary protrusion which requires individual canine retraction after maxillary first premolar extractions were included in the study. Each patient's maxillary arch was divided into the right and left quadrants. Experimental and conventional sides were randomly allocated. The incisions were given through the periosteum using a piezosurgical knife on the experimental side. Bilaterally, in both the groups, canine retraction was initiated using elastic chain applying 120 g of force on both sides. Follow-up was done every 2 weeks for activation. **Results:** As compared to the conventional approach, piezocision is 1.5 times faster. **Conclusion:** Piezocision is an efficient technique that aids an orthodontist to accomplish speedy orthodontic tooth movement without other detriments of the substantially time-consuming and traumatic surgical approaches. Other advantages include decreased surgical procedural time and nominal postoperative discomfort to the patients.

Keywords: *Canine retraction, conventional side, piezocision, rate, regional acceleratory phenomena, speed*

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Introduction

"When are you taking off my braces?" is the question most often addressed to orthodontists treating malocclusions in their routine practice. Esthetics and duration of the entire treatment are the two important criteria for a patient undergoing treatment.[1]

Decreasing the treatment duration is one of the most challenging tasks. It is one of the deterrents faced by orthodontists and causes irritation among adult patients and also increases the risks of caries, gingival recession, and resorption of roots. Many attempts have been made to create various approaches both preclinically and clinically for achieving faster results, but still, there are a lot of uncertainties and unanswered questions toward most of these techniques. Most efforts are broadly being categorized into biological, physical, biomechanical, and surgical approaches.[1,2]

Most of these surgical techniques have been found to be quite invasive. Hence, a new technique which is minimally invasive and a flapless procedure combining microincisions was introduced. This is known as piezocision.[2]

Piezocision to increase orthodontic tooth movement was based on the work of Wilcko *et al*. and has its base in

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the regional acceleratory phenomenon (RAP) described by Frost in 1983. RAP is the bone tissue reacting with rapid, transient localized osteopenia, after a surgical insult, resulting in a phenomena involving no bone volume loss but decline in the density of the bone making it more "malleable" and thereby helping the teeth to move more quickly.[3]

Newer piezocision techniques, proposed by Dibart *et al*., involve their ease of use and minimal trauma. It is particularly indicated in those cases in which the orthodontic movement is aimed at resolving crowding and/or malalignment in the anterior region, selected Class II malocclusion, selected Class III malocclusion, rapid orthodontic treatment, and molar distalization.[4,5]

As every coin has two faces on it, each technique comes with its required and unrequired effects. As a clinician, it is our duty to weigh the pros and cons of each technique and choose which would cause the least discomfort and at the same time deliver the best outcome.

All the literature which is available is in the form of case reports. Till date, none of the potential studies have compared the overall treatment duration and outcome between different groups. To meet this expectation, there is a need for a randomized control trial comparing piezocision retraction side and conventional retraction side. Hence, the aim of this study is to measure the speed of orthodontic tooth movement in the piezocision retraction group and to measure the speed of orthodontic tooth movement in the conventional retraction group and to compare the speed of orthodontic tooth movement between piezocision and conventional retraction groups.

Materials and Methods

This was a split-mouth study design with random allocation, in which ten patients were evaluated for piezocision's effects on the speed of movement of tooth. Patients were selected from the routine orthodontic cases in the department. Cooperative patients with age above 18 years having Class II division I malocclusion or bimaxillary protrusion which requires individual canine retraction after maxillary first premolar extractions were included. Each patient's maxillary arch was divided into the right and left quadrants. Experimental and conventional sides were randomly allocated.

Patients with a history of orthodontic treatment, trauma, periodontal disease, endodontic treatment with anteriors, dentofacial anomaly, Temporo Mandibular Joint (TMJ) abnormality, and systemic diseases were excluded.

Treatment was done using 0.018" Roth appliance (3M Unitek, Monrovia, Calif). After alignment and leveling, a 0.016 special plus AJ Wilcock wire was placed. A digital vernier caliper was used to measure the speed of tooth movement. Piezotome machine (Surgystar, Dmetac, Korea) was used to create cortical alveolar incision [Figure 1].

For the patients in Group I, the piezocision surgery was done a week after inserting the retraction wire. Local anesthesia was given followed by two vertical interproximal incisions, below the interdental papilla, on the labial surface of the experimental side with the help of a blade. The incisions were given through the periosteum till the alveolar bone. A piezosurgical knife was then used to create the cortical micro-openings to the depth of approximately 3 mm [Figure 2]. Elastic chain was used for the individual canine retraction. 120 g of force was applied immediately after surgery. Patients were discharged home with the prescription of antibiotics and analgesics and a rinse with chlorhexidine mouthwash twice a day and application of ice extraorally for the first 24 h. Patients were recalled after every 2 weeks for activation.

Conventional individual canine retraction was done in this group. After leveling and alignment, elastic chain was used for the retraction on 0.016" special plus AJ wilcock wire. 120 g of force was applied followed by activation every 2 weeks

Evaluation of retraction method

Speed and amount of retraction were evaluated after complete space closure by the following methods: (1) cast method and (2) clinical evaluation.[6]

In cast method, three casts were prepared. For the first cast, impression was made 1 day before piezocision surgery/start of retraction. For the second cast, impression was taken when the canine was midway during retraction, and for the third cast, impression was

Figure 1: piezotome machine (Surgystar, Dmetac, Korea) to create cortical alveolar incision

taken when the canine on the experimental side touched the premolar. The measurements were made using a jig.

T0 was considered as a position of canine on the cast 1 day before surgery/start of retraction.

T1 was considered when the canine on the experimental side reached the midway during retraction.

T2 was considered till the time canine on the experimental side touches the premolar [Figure 3].

For clinical evaluation, patients from both the groups were recalled after every 2 weeks. Examination was done for the speed of tooth movement using digital vernier calipers.

Results

The rate of space closure in all ten patients was more on the experimental side compared to the conventional side at all follow-up appointments. In the clinical method, the amount of tooth movement during 2nd week was 0.93 mm and 0.65 mm on the experimental side and conventional side, respectively. Then, there was a gradual space closure on the experimental side, but then again, there was a sudden spurt in tooth movement by the end of the 10th week (2 months) that is 0.87 mm. Total duration required for complete space closure on the experiment was 3 months and 2 weeks, and on the other hand, 2.3 mm of space was remaining on the conventional side [Graph 1].

In cast method

In cast method, the amount of space present on both the sides was 5.4 mm and 5.5 mm, respectively (T0) [Table 1]. The amount of space remaining by the end of 7th week (T1) was 2.7 and 4.0 mm, respectively, on both experimental and conventional sides [Table 2]. By the end of 3 months and 2 weeks, the amount of space remaining to be closed on the experimental and conventional sides was 0 mm and 2.3 mm, respectively [Table 3]. Piezocision is 1.5 times faster than the conventional approach.

Discussion

To decrease the overall duration of the treatment by accelerating the orthodontic tooth movement has been long sought after and the search for the ideal method to do so has not yet been quenched, despite the long path that orthodontics has plodded. Surgical intervention to increase the speed of orthodontic movement of tooth has been used in many forms for more than a hundreds of years. In 1959, Köle described a surgical procedure which combined vertical interproximal cortical incisions and subapical horizontal osteotomy cuts from buccal to palatal plate. He explained that rapid tooth movement was allowed by "bony block" movement concept.[7] In 1981, Frost witnessed surgical wounding of the bone inducing a better bone turnover and also decreased bone density in the immediate surrounding of the surgical site (RAP).[3] Wilcko in 2001 introduced a procedure combining alveolar corticotomies and bone grafting to avoid the risk of dehiscence and fenestration when increasing the possibility of orthodontic corrections.[1] Vercellotti *et al*. in 2007 described

Table 1: Amount of space present in both the groups at the start of retraction (T0)

Group	*n*	Mean	SD	SE	*t*	*P*
Experimental	10	5.4	1.10	0.35	-0.104	0.918
Conventional	10	5.5	1.04	0.33		

SD=Standard Deviation; SE=Standard Error

Table 2: Amount of space remaining in both the groups at the end of 7th week (T1)

Group	*n*	Mean	SD	SE	*t*	*P*
Experimental	10	2.7	0.73	0.23	-3.496	0.003
Conventional	10	4.0	0.86	0.27		

SD=Standard Deviation; SE=Standard Error

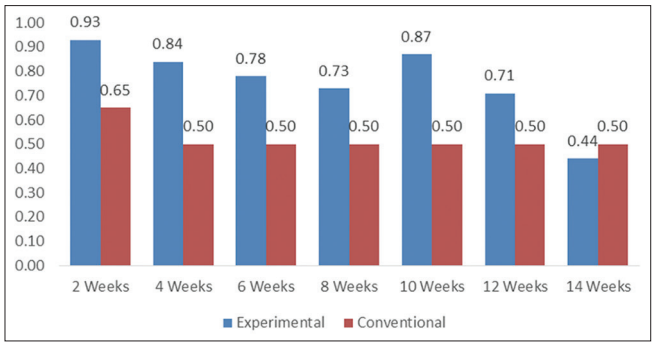
Table 3: Amount of space remaining in both the groups after 3 months 2 weeks (T2)

Group	*n*	Mean	SD	SE	*t*	*P*
Experimental	10	0.0	0.00	0.00	-8.493	0.000
Conventional	10	2.3	0.86	0.27		

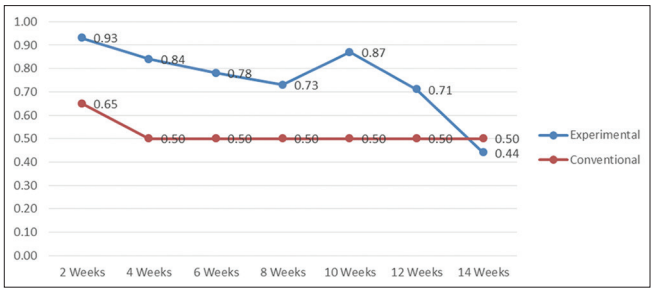
SD=Standard Deviation; SE=Standard Error

Figure 2: piezocision cut

Figure 3: palatal jig to evaluate retraction (T0, T1, and T2)



Graph 1: Comparison of speed of orthodontic tooth movement in the experimental side and conventional side



Graph 2: Mean movement of canine on the experimental and conventional sides

reduction in orthodontic treatment time by 60%–70% after corticotomy using a piezosurgical microsaw.[8] Due to its small size and precision, it resulted in precise osteotomies, thereby reducing the risk of osteonecrosis.[9]

Although effective, corticotomy techniques described above show major postoperative discomfort. The elevation of mucoperiosteal flaps and to the length of the surgery raised lack of enthusiasm among both patients and dental community. To overcome the shortcomings of other corticotomy techniques, an ingenious, minimally invasive, flapless procedure combining piezosurgical microincisions was presented known as piezocision.[1]

This was a prospective split-mouth study with random allocation designed to assess the difference in the rate of tooth movement by comparing the experimental side and the control side in the same patient. Immediately after piezocision cuts are made with a piezoelectric knife, a vibrant healing process occurs at the site of the injury, which is proportional to the extent of the surgical insult.[10] We noticed that at first visit, i.e., after 2 weeks (14 days), there was 0.93 mm of movement of tooth on the experimental side compared to 0.65 mm of movement of tooth on the conventional side [Graph 1]. Then, there was a gradual space closure on the experimental side, but then again, there was a sudden spurt in tooth movement by the end of 10th week (2 months) that is 0.87 mm [Graph 1]. This sudden spurt in tooth movement is due to RAP which starts as early as 24 hours and peaks in 1 or 2 months and then slows down, followed by disappearing as remineralization sets [Graph 1]. Burst of local activity (bone remodeling and surges in osteoclastic and osteoblastic activity) creating a transient osteopenia is responsible for RAP as the teeth move in a more "pliable" environment. The judicious use of localized demineralization process, thereby reaching a positive orthodontic outcome in a minimal invasive manner, is the essence of piezocision.[11] Total duration required for complete space closure on the experimental side was 3 months and 2 weeks, and on the other hand, 2.3 mm of space was remaining on the conventional side. *P* value was significant at 10th week, 6t^{h} week, and 8t^{h} week [Graph 1]. We are, in essence, using the physiologic reaction of the body to local injury helping us achieve our therapeutic goals. In this study, we have not used bone graft as the incision was localized (mesial and distal to the canine) and not generalized (full mouth). Tooth movement is directly related to severity of bone injury. There will be greater amount of osteopenia when the incision is full mouth compared to localized incision. Hence, there was no need to give bone graft to increase the bone volume.[4]

Burstone explained the movement of tooth in three stages. The initial phase, lag phase, and postlag phase. During the initial phase, movement of tooth takes place very rapidly over a short distance and then stops. The tooth movement in the initial phase is between 0.4 and 0.9 mm and usually occurs in a week's time. During the lag phase, there is little or no tooth movement. This phase extended for 2–3 weeks and sometimes as long as 10 weeks. Once the lag phase is overcome, tooth movement progresses rapidly [Graph 2].[12]

In our study, on the conventional side, canine retraction rate was initially 0.65 mm in the 2nd week and then there was a continuous 0.5 mm of tooth movement from 4th week to 14th week. This can be due to the continuous force (120 g) that is applied at every 2 weeks [Table 1], which did not corroborate with the stages explained by Burstone.

Recently, Noha Hussein Abbas *et al.* assessed the effectiveness of corticotomy-facilitated orthodontics and piezocision in rapid canine retraction. They observed the gradual growth in the canine crown tip due to regional acceleratory phenomena. They have concluded that piezocision was 1.5 times faster than the conventional method. Our findings, comparing the speed and duration of treatment between piezocision side and conventional side, also corroborate with their study.[13]

Lawrence P. Lotz carried out a study comparing the time required for canine retraction using two different

preadjusted bracket systems in a human sample. Due to this movement, anchorage loss was also evaluated using an acrylic palatal jig (plug). On the same patient, the plug can be transferred from the initial cast to the final cast.[14]

As described by Lotz, jig was prepared to evaluate the amount of space closure in cast method. The amount of space in both experimental and conventional sides was 5.4 and 5.5 mm, respectively [Table 1], i.e., T0. The amount of space remaining when the canine was halfway that is approximately around 7th week was 2.7 and 4.0 mm, respectively, in experimental side and conventional side [Table 2], i.e., T1. By the end of 3 months and 2 weeks, the amount of space remaining to be closed on the experimental and conventional side was 0 mm and 2.3 mm, respectively [Table 3], i.e., T2.

Aksakalli *et al*. concluded that piezocision-assisted distalization accelerates tooth movement, reducing the anchorage loss of posterior teeth, thus having no opposing effects on periodontal health.[15]

The patients were discharged home with the prescription of antibiotics and analgesics and were asked to rinse twice daily with chlorhexidine mouthwash and application of ice extraorally for the first 24 h. We know that piezocision involves minimum risk, i.e.,; pain, swelling, and bleeding. However, none of the ten patients in our study complained about the above-mentioned complications.[4]

From the patient's view, accelerating the movement of tooth is favorable, as the duration of the treatment, frequently months or even years, is considerably long. From the clinician's point of view, there are other disadvantages such as root resorption, gingival inflammation, and dental caries associated with prolonged duration of treatment.

Thereby, as research in orthodontics is moving ahead, an attempt is being made in leaving no stone unturned to find that one technique of reducing the duration of the treatment for the patient. Piezocision poses a promising future in this aspect.

Conclusion

1. The speed of orthodontic tooth movement with piezocision retraction side was 5.4 mm in 3 months and 2 weeks
2. The speed of orthodontic tooth movement with conventional retraction side was 3.2 mm in 3 months and 2 weeks
3. The speed and duration of orthodontic tooth movement was 1.5 times more rapid on the piezocision side compared to the conventional side.

Piezocision is a pioneering approach, with minimal invasive procedure carried out to accomplish rapid orthodontic tooth movement without the shortcoming of extensive and traumatic surgical approaches. This innovative technique allows for the correction of severe malocclusion in shorter duration. It offers shorter surgical time, minimal postoperative discomfort, and a high tolerance for patients. Piezocision could be an adjunctive treatment procedure for increasing more number of adult patients in orthodontic practice.

The rate of space closure in all ten patients was considerably greater on the experimental side than on the conventional side by both the methods during all follow-up appointments. On the conventional side, activations were made too frequently, which could have led to a relatively delayed response of tooth movement. This could be the only drawback in our study design.

The future scope of the study could be a similar study with larger sample size and full-mouth approach to evaluate the speed of tooth movement during *en masse* retraction and crowding correction can be carried out. A study evaluating the tip of canine and anchorage loss during retraction can be done. Moreover, cephalogram and cone-beam computed tomography can also be used as an additional method to calculate the speed of orthodontic tooth movement.

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Conflicts of interest

There are no conflicts of interest.

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