

Accelerated Tooth Movement by Piezocision: A Systematic Review

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Abstract

Background: The demand for esthetic improvement among adult patients is increasing in our society. Currently adult patients seeking orthodontic treatment for either esthetic purposes or functional improvement or both are increasing in number. The drawback of going through orthodontic treatment among adults is the duration of orthodontic treatment that could take up to three years. Surgical adjunctive methods to accelerate orthodontic treatment has been described in literature, however the main issue is the invasive nature of the surgery. Piezocision is a minimally invasive and conservative procedure that is aimed to reduce the duration of treatment and postoperative complications. The aim of this systematic review is to gather updated data in regard to piezocision method for orthodontic treatment.

Materials and Methods: Two automated databases (Google Scholar and PubMed using English-language literature) were utilized for this systematic review, operating precise exclusion and inclusion criteria and keywords. The exploration was done in September 2017 and was updated in January 2018.

Results: Our inquiry uncovered eight studies that met the exclusion and inclusion criteria. These studies investigated different aspects of accelerated tooth movement, including: new techniques, piezocision method, and updated studies in tooth movement.

Conclusions: Piezocision is a minimally invasive and novel method that permits fast orthodontic tooth movement minus the necessity of the traditional extensive surgical method.

Keywords: Accelerated Tooth Movement; Piezocision; Adult Orthodontics; Periodontal Surgery; Bone Graft

Introduction

The demand for shorter orthodontic treatment time among adults is increasing drastically [1]. Several methods to accelerate orthodontic-induced tooth movement have been accessed in the literature since 1959 [2].

Frost described the regional accelerated phenomenon (RAP) in the orthopedic literature; when the alveolus undergoes transient decalcification-recalcification processes due to injury, it elucidates its osteopenic nature where there is a decrease in the density of bone while its volume remains the same [3]. This phenomenon allows for orthodontic-induced tooth movement to take a rapid pace [4].

Piezocision (corticotomy) is a conservative approach that includes piezoelectric incisions, micro-incisions, and soft or hard tissue selective tunneling aimed towards grafting [5]. Piezosurgery was introduced with the conjunction of conventional flap elevations to

generate a setting conducive to fast tooth movement [6]. A paradigm shift towards more conservative methods was developed in the following years.

The rationale behind considering minimally invasive piezocision instead of the conventional corticotomy associated with a flap is due to the superior advantages of the first technique; that lie in reducing post-operative discomfort, can be performed multiple times during the opportunity window of RAP until desired orthodontic goals are met, can aid in the improvement of the periodontium because it allows for both soft tissue and or bone augmentation [7]. A difference in the 'opportunity window' was reported based on animal studies, that cuts produced by piezoelectric tips possess a superior length in the 'opportunity window' that reaches up to 6 months to bur corticotomies, which have only 3 - 4 months [8].

There are several studies that were conducted to discuss accelerated tooth movement by corticotomy. However, few studies have investigated accelerated tooth movement by piezocision. Consequently, this review aim was to collect all updated and available studies including imperative information concerning the piezocision technique to accelerate movement of teeth.

Materials and Methods

This review was reported in accordance with the PRISMA statement.

Focused question

"Recent developments and clinical applications in piezocision as a mean of accelerating orthodontic-induced tooth movements".

Search strategy

A protocol-based approach was employed to search literature and identify relevant studies conducted with respect to the focus question. The search was conducted in September 2017 and updated in January 2018. Two electronic databases, PubMed and Google Scholar were searched with relevant search terms. The proposed keywords for the search were "accelerated tooth movement" and "piezocision". While searching in Google Scholar, these terms were entered in the following combinations; the terms "accelerated tooth movement" were combined with "piezocision". For PubMed search, the keywords were converted to Medical Subject Heading (MeSH) terms. The MeSH 2017 Browser in the online portal of the United States National Library of Medicine was used to generate MeSH equivalents wherein "accelerated tooth movement" and "piezocision" were both retained. A combination of these terms was used for the PubMed search and no filters were applied so as to retrieve maximum possible results. The database was scrutinized by the reviewers of this study. The final decision on inclusion/exclusion was made by the reviewers according to adherence to the following criteria.

Inclusion criteria

- Original research published in the English language.
- Articles published for a period of 10 years from 2007 - 2017.
- Studies conducted on human subjects.

Exclusion criteria

- Articles that described accelerated tooth movement techniques in areas of the oral cavity excluding the Piezocision technique.
- Articles that discussed accelerated tooth movement by percentages and samples taken from animals.
- Review articles.

Titles and abstracts of the articles generated by the online databases after entering the relevant search terms were read and assessed by application of the eligibility criteria by the study reviewers. For articles which their abstracts met the inclusion and exclusion criteria, full text was accessed. Free full text articles were downloaded directly from the search URLs generated by the database while restricted access articles were downloaded using the institutional access of King Abdul Aziz University Library. The retrieved full text articles were then read by the reviewers and categorized as being relevant or irrelevant. No disagreements occurred between the authors in relation to

the suitability of the selected articles. Reference lists of the qualified articles were examined in order to identify cited studies that may not have been captured by electronic searches. A summary of the systematic review search strategy is given in figure 1.

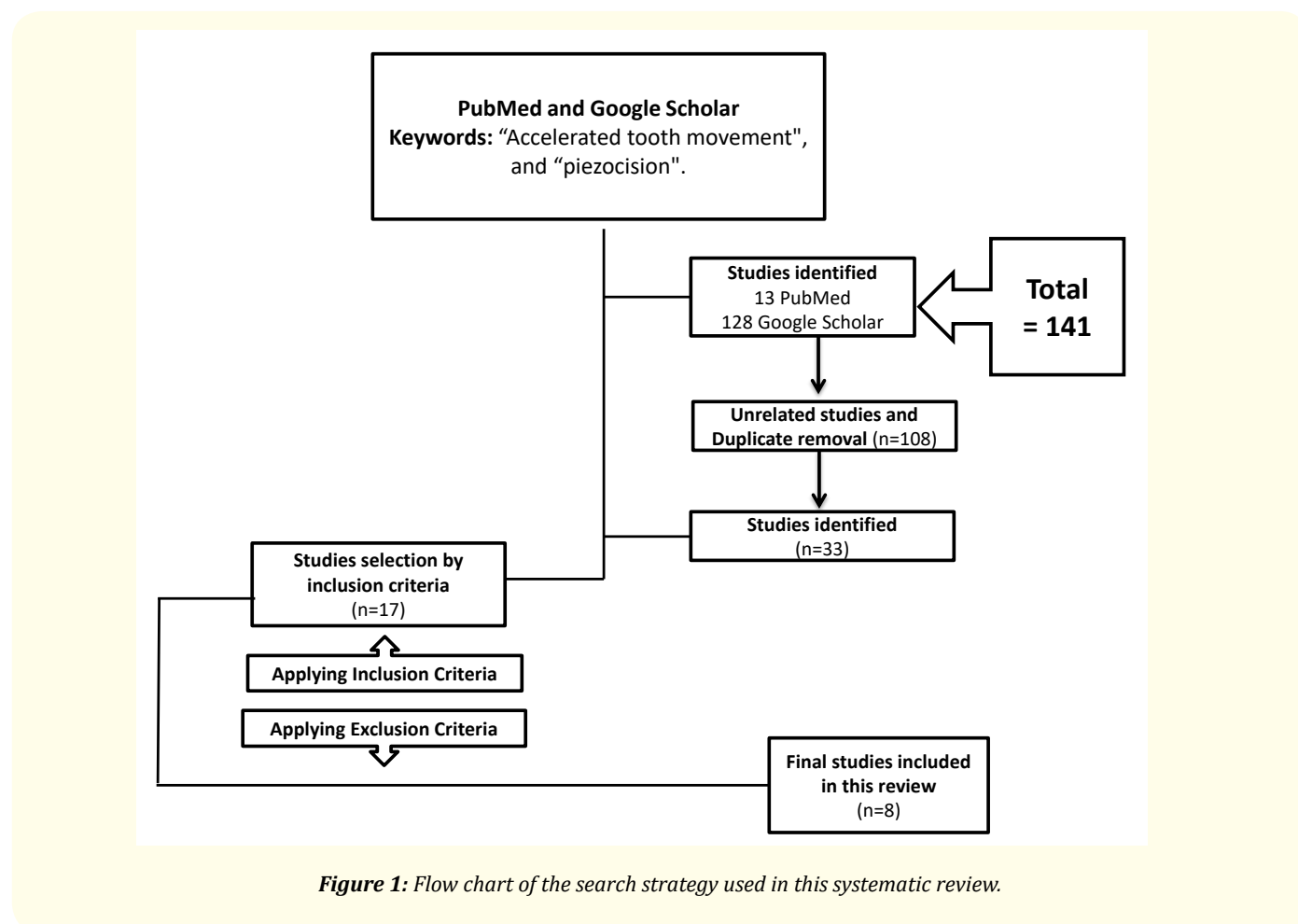


Figure 1: Flow chart of the search strategy used in this systematic review.

Results and Discussion

Our exploration uncovered eight studies, which met the exclusion and inclusion criteria. These studies investigated different aspects of accelerated tooth movement, including: new techniques, piezocision method, and updated studies in tooth movement. The studies included in this systematic review were one split mouth study [1]; one randomized controlled trial [2], four case reports [3,6-8], one controlled cross-sectional study [4] and one controlled longitudinal study [5]. The systematic review included eight studies with a total sample of 72 subjects that were treated from universities outpatient departments of dental schools, and hospitals. In all of the studies, the procedures were performed on systemically healthy persons. In regard to the surgical technique performed, four studies were performed with flap reflection [7,9-11] and four studies were done with no flap reflection [1,12-14]. The placement of bone graft was made in four studies [1,7,10,14] and in the other four studies, bone graft was not placed [9,11-13]. In regard to the effect on root resorption, one study showed significant root resorption when piezocision was performed [12] and another study found no noteworthy variance in root resorption between the combination of orthodontic treatment with piezocision [9] and conventional orthodontic treatment, whereas one study [11] found that root resorption was less in case of piezocision compared to conventional orthodontic treatment.

A summary of all included studies is presented in table 1.

Authors/ Study Design	Number of Subjects	Type of Surgery (With flap/No flap)	Bone Graft Used (Yes/No)	Main Results	Main Conclusions
Patterson, <i>et al.</i> [12] (2017)	Fourteen patients were incorporated in this split-mouth study; 1 side served as the control side and the other side was assigned to piezocision. Vertical corticotomy cuts were performed of 4 to 5 mm in length on both sides of each piezocision premolar, and 150-g buccal tipping forces were applied to the premolars.	(No flap)	(No)	Notably larger full amount of root resorption were observed on the piezocision sides when compared to the control sides (P 5 0.029). Once that was joined with the orthodontic root resorption located on the piezocision-treated teeth, there was a statistically noteworthy 110% average upsurge in volumetric root loss when competed with the control side (P 5 0.005).	Iatrogenic root resorption is increased when the piezocision procedure which starts the regional acceleratory phenomenon is used in combination with orthodontic forces. Piezocision applied near to the roots might trigger iatrogenic harm to the neighboring roots and must be utilized with vigilance.
Charavet, <i>et al.</i> [9] (2016)	Twenty-four adult patients possessing mild over-crowdings. Group I (control) - 12 that were treated with conventional orthodontics. Group II (test) - 12 that received piezo-assisted orthodontics.	(With flap) Piezocision surgery.	(No) Neither grafting material nor sutures were used.	Overall treatment period was considerably decreased by 43% in the piezocision group when compared to the control group. No upsurge in root resorption has been witnessed in either group. Scars were detected in 50% of the piezocisions patient group. Satisfaction level of patients was considerably improved in the piezocision group compared to the control group.	The piezocision method appeared to have an effect in accelerating orthodontic tooth movement. The hazard of remaining scars may bound the indications for piezocision in patients possessing a high smile line.
Dibart [20] (2016)	Case report	(With flap)	(Yes)	This method may be utilized for the entire mouth, the cuts being concurrently made at the mandible and the maxilla. (Generalized piezocision) or for parts of the dentition (localized Piezocision) to accomplish certain confined results (extrusion, intrusion, teeth distalization, etc.).	Piezocision is a novel, minimally invasive surgical procedure that allows fast orthodontic tooth movement minus the disadvantage of the traumatic and extensive traditional surgical method.
Aksakalli, <i>et al.</i> [13] (2016)	Twenty canines from the maxilla of 10 patients were assessed using split mouth design. Group I (control) - 5 patients that were undergoing orthodontic treatment without piezocision. Group II (experimental) - 5 patients that received piezo-assisted distalization.	(No flap) piezocision surgery.	(No)	Three-dimensional investigation of the models uncovered noteworthy contrasts in toothmovement (greater canine distalization and lesser anchorage loss) between the control and experimental groups. The distalization period was abbreviated in the experimental group.	Tooth movement is accelerated by Piezocision-assisted distalization. Periodontal health is not adversely affected by Piezocision.

Abbas, <i>et al.</i> [11] (2016)	Twenty patients aged from 15-25 possessing Class II Division 1 malocclusions were allocated into 2 identical groups. Group I (control) - 5 patients: one side of the maxilla was arbitrarily chosen to be treated by corticotomy, The contralateral side(2 nd side) of this group served as the control. Group II - 10 patients: by piezocision treatment was used for one side of the maxilla, and the contralateral side functioned as the control group.	(With flap) Perforations and cuts were made using a piezotome.	(No)	Greater rates of canine movement were produced by corticotomies at 4 time points compared to did piezocision. The residual studied variables showed no variances amongst the experimental and the control sides.	Accelerating canine retraction can be efficiently achieved by using piezocision and corticotomy-facilitated orthodontics as treatment modalities.
Keser, <i>et al.</i> [14] (2013)	Case report	(No flap) 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.	(Yes) Placement of hard-tissue and soft-tissue grafts in case of preexisting bony dehiscences, fenestrations, thin buccal alveolar bones, or mucogingival defects	In current years, the method has advanced to a further staged style, with selected segments or areas of the arch demineralized at diverse timeframes throughout orthodontic treatment to aid in attaining certain outcomes.	Piezocision is a novel, minimally invasive method designed to permit fast orthodontic tooth movement minus the disadvantage of traumatic and extensive. This case report demonstrates how piezocision may be used serially in designated patients to create outcomes that are both satisfactory and timely.
Sebaoun, <i>et al.</i> [1] (2011)	Case report	(No flap)	(Yes)	Joined with suitable treatment planning and respectable understanding of the biological events included, this original method may manipulate alveolar bones' local metabolism in order to attain fast and steady orthodontic results. Piezocision permits the correction of severe malocclusions rapidly minus the disadvantages of conventional traumatic corticotomy techniques.	This novel method permits the orthodontic improvement of severe malocclusions in fewer than a semester minus the disadvantage of the traumatic and extensive surgical methods. Piezocision uncovers itself as an effective device in the arsenal of multidisciplinary dental team for our adult patients.
Dibart, <i>et al.</i> [7] (2009)	Case report	(With flap) Piezoelectric corticotomy performed by Piezotome	(Yes) Soft and hard tissue grafts may be added by means of a tunneling technique.	Joining localized piezoelectric corticotomies and buccal interproximal microincisions enables the creation of a significant amount of demineralization all around the teeth in the zones of tooth movement, making this a very appealing substitute to the more aggressive and conventional techniques. A technique that is minimally invasive, combining selective tunneling that allows for hard- or soft-tissue grafting with microincisions and piezoelectric incisions levels.	Piezocision is a novel, minimally invasive procedure that permit fast orthodontic tooth movement minus the disadvantage of the traumatic and extensive traditional surgical method. Piezocision demonstrates efficiency from the clinician's and patient's perspective and offers benefits that would result in better acceptance in the patient and dental communities.

Table 1: Summary of all included studies in the systematic review.

Discussion

The systematic review presents a comprehensive compilation of evidence taken from eight articles, which included original studies. The sample size was up to 72 subjects seeking accelerated tooth movements by the use of piezocision. This review included patients of age 15 - 25 years and older patients as well seeking orthodontic treatment. All included studies confirmed faster treatment time by the use of piezocision regardless of the surgical technique (Table 1).

Studies included in this review are varied in techniques. It is noteworthy that incisions made weather to the entire root length or as small as 4 - 5 mm apical to the interdental papilla resulted in a similar acceleration of tooth movement. No studies reported adverse effects related to the periodontium, however, the more length of an incision could be associated with higher risks of periodontal damages [11] and more studies should be done to investigate it. One study used laser to perform the gingival cuts [12] compared to the other studies, which used the knife blade. No studies evaluated the effect of laser incisions on gingival and periodontal tissues compared to blade incisions when performing piezocision. Only one study [11] reported the removal of bundle bone of the extraction sockets, compared to the other more conservative surgical approaches. The use of bone grafting in some cases were performed to augment the bone volume in cases of preexisting bony dehiscence, fenestrations, thin buccal alveolar bones, or mucogingival defects [1,7,10,14]. One important finding as well, is the difference in timing of the surgery, where some authors performed the piezocision surgery immediately after placement of orthodontic appliance [12,13] compared to other authors who performed the surgery after 1 week of orthodontic appliance insertion [7,9,10,14]. Future studies should compare different procedures for their efficacy and complications to determine the optimal surgical protocol. There is controversy in regard to the effect of piezocision on roots resorption. One study reported adverse effect on roots resorption when piezocision is performed [12] compared to one study that reported less resorption compared to conventional orthodontic treatment [11] and another study that reported no significant changes between the two treatment modalities [9]. The Future studies should be made in favor of inspecting the effect of piezocision on roots resorption on a great scale to sanction the minimal invasiveness of the technique.

Conclusion

Piezocision is defined as a novel, minimally invasive procedure that permits fast orthodontic tooth movement minus the necessity of the extensive traditional surgical method. Piezocision demonstrates its efficiency in reducing the period needed for orthodontic treatment and suggests benefits that will result in better recognition among patients seeking faster results compared to conventional orthodontic treatment. However, more clinical trials are encouraged to inspect the result of piezocision on the resorption of roots.

Conflict of Interest

No conflict of interest to declare.

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