

The Effectiveness of Minimal Invasive Piezocision Surgery in Accelerating Tooth Movement in Orthodontic Treatment: A Review Study

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Abstract

Long duration fixed orthodontic treatment has several side effects such as pain, discomfort, increased risk of caries, gingival recession and external root resorption, thereby decreasing patient adherence. Therefore, dentists and patients are interested in procedures that can speed up tooth movement by reducing the duration of treatment. Minimally invasive surgical assisted approaches such as piezocision have been shown to be clinically effective. Piezocision was used to decorate the alveolar bone after gaining access through an interdental vertical gingival incision. Piezocision is an efficient treatment to accelerate canine retraction. The overall treatment time was significantly lower when using piezocision. Piezocision had a progressive effect and greater efficacy on the maxilla compared to the mandible. However, there is substantial heterogeneity in minimally invasive surgery to accelerate canine movement in the various studies available. Piezocision is more promising for clinical applications than conventional corticotomy and has been studied extensively. There is a high meta-analysis heterogeneity in piezocision surgery, so it still requires further research.

Keywords: duration of treatment; dentistry; human and health; piezocision; retraction; tooth movement

1. Introduction

Comprehensive orthodontic treatment frequently takes longer than 1.5 years when fixed orthodontic appliances are used to treat moderate to severe cases of malocclusion, while there are noticeable variations that can be impacted by a variety of circumstances.(Alfawal et al., 2016) The optimal orthodontic force efficiently pushes the teeth into the appropriate position without the patient experiencing any pain or tissue damage.(Krishnan and Davidovitch, 2006) Fixed orthodontic treatment in long duration has Several adverse consequences, including discomfort, increased risk of cavities, gingival recession, and external root resorption, reduce patient compliance.(Alfawal et al., 2016; Cassetta et al., 2016) Additionally, because to social and cosmetic considerations, the majority of adult patients want to finish their treatment as soon as possible. Dental professionals and patients are therefore interested in techniques that can quicken tooth mobility.(Alfawal et al., 2016)

Kole has been doing surgery since the 1950s that involves a full-thickness flap and the excision of the interdental alveolar cortical bone. This method is said to be more effective, cause root resorption, and require less retention time since it allows movement of the bone blocks rather than one tooth at a time. Recent studies have shown that Regional Accelerator Phenomenon (RAP) is induced by corticotomy using scalpel blades and mallets which are used to incise the gingiva and wound the cortical alveolar bone.(Yi et al., 2017) The medullary bone can respond to injury by supplying cells, calcium, and other minerals to heal when mucoperiosteal flaps produce ischemia events. An RAP response that results in increased bone turnover and lower bone density can be caused by this. Lifting the entire flap in conjunction with the surgery will therefore result in more bone damage, a stronger RAP reaction, and perhaps even a higher OTM rate.(Librizzi et al., 2017)

This surgical method is more invasive than non-surgical interventions, therefore patients need to be informed about postoperative conditions and the potential risks of surgery.(Gkantidis et al., 2014) Corticotomy-assisted orthodontic therapy is still uncommon among patients, primarily because to the intrusive surgery, postoperative discomfort, and complications.(Librizzi et al., 2017) Many methods have been developed to shorten the course of treatment. Surgical-assisted approaches such as micro-osteoperforation and piezocision have been shown to be clinically effective.(Li et al., 2021) Piezosurgery is claimed to be ideal for performing osteotomy on thin and brittle bones. The ultrasound device is precise and easy to handle, and the microvibration allows selective cutting of only mineralized structures, creating minimal damage to adjacent tissues.(Wu et al., 2015) The traditional corticotomy has been replaced by this minimally invasive procedure. Piezocision has undergone significant research and is more promising than standard corticotomy for therapeutic applications because to its least invasive features.(Librizzi et al., 2017).

2. Review

The relatively minimally invasive technique called as "piezocision" was proposed by Dibart et al. and involves using a piezoelectric knife to decorate the alveolar bone following a vertical interdental gingival incision. Piezocision is an efficient treatment modality to accelerate canine retraction.(Hatrom et al., 2020) Piezocision demonstrated a mean improvement of 43% and required substantially less time overall than the control group.(Shirude et al., 2018) However, piezocision studies have yielded contradictory.(Hatrom et al., 2020) This is because some studies showed that corticotomy and piezocision did not show root resorption, whereas other studies showed that periodontal disorders caused root resorption in one of the six.(Chen et al., 2020)

Young mice were used in a study by Kernitsky et al. to assess the effects of two distinct penetration depths—intracortical (shallow) and transcortical (deep)—performed with a piezoelectric knife. Rats and humans are similar and different. In comparison to humans, mice have a basic metabolic rate that is about 6.4 times higher. We are able to monitor cyclical biological events (such RAP following injury) over a shorter period of time because mouse turnover and maturation are faster. RAP is more intense when a piezoelectric blade penetrates the cortex deeply and enters the medullary region, leading to higher levels of osteoclastic activity and bone remodeling than with superficial wounds. This causes more extensive bone demineralization when combined with orthodontic treatment and has unusual clinical implications for the rate of tooth movement (Kernitsky et al., 2021).

According to Aksakalli et al study, 's piezocision was done before to canine distalization and following the alignment and leveling phases. On the mesiobuccal and distobuccal sides of the maxillary canines, a No. 15 needle was used to make two vertical interproximal incisions into the periosteum and beneath the interdental papilla (avoiding free gingiva). The cut line is used as a guide for the groove between the teeth's roots. The

mesial and distal sides of the maxillary canines had a vertical interproximal incision made 5 mm apical to the interdental papilla. Apically, the incision is about 10 mm long. To create a 3 mm deep cortical alveolar incision, a piezo scalpel (BS1 insert, Piezotome, Satelect Acteon, Merignac, France) was employed (Figure 1). The depth is verified by the millimeter mark on the piezo scalpel. Ligation with 0.016 x 0.022 inch maxillary stainless steel archwire. After piezocision, the distalization step began utilizing an elastomeric chain with a 150 g estimated force. Patients underwent examinations every two weeks, and each appointment included a new elastomeric chain (Aksakalli et al., 2016).



Fig. 1. Piezoelectric corticotomy.

In the available studies, there is a lot of variation in minimally invasive surgery to speed up canine movement. Multiple factors, including the use of various archwires and inconsistent forces on the moving canines, variations in measurement and operational methods, variations in retraction forces, and variations in canine movement distance measurement techniques, can all contribute to the meta-high analysis's heterogeneity. Furthermore, the lateral incisors, which are regarded as an unstable point because they can move during canine retraction, should not be used as a reference point for measuring. High variability was also seen in treatment duration. As a result, these findings should be confirmed in patients needing extensive orthodontic care, as studies that looked at changes over the course of a month were found insufficient to detect root resorption during the course of an orthodontic treatment (Fu et al., 2019).

In the first two months following surgical intervention, piezocision boosted the rate of canine retraction by 0.57 mm per month, according to meta-analysis. Additionally, piezocision resulted in a total molar anchoring loss of 0.53 mm. These results show that the piezocision accelerates canine retraction at a statistically significant difference, proving the efficiency of the procedure. Meta-analyses were conducted without attention to age variation, ignoring correlations between the two sides of the mouth during sample size calculation and statistical analysis, and ignoring baseline features of both sides during randomization. The current meta-analysis demonstrates the effectiveness of piezocision in reducing the overall length of orthodontic therapy. As a result, the length of the treatment is shortened by more than three months. According to Charavet et al., patients in their mid-thirties reported higher pain following surgery than younger patients aged 13–19 in the Yavuz research, who reported less pain. This suggests that disparities in age between studies may be to blame for discrepancies in pain reports (Mheissen et al., 2020).

Tunçer et al. has conducted research on the efficiency of the piezo surgical technique in en-mass retraction. mass retraction (Tunçer et al., 2017). However, in contrast to research by Wu et al. which states that piezocision can reduce treatment time at the leveling, alignment and space closure phases of extraction in surgical cases of Class III (Wu et al., 2015). En-mass retraction in conjunction with piezocision is an efficient

therapeutic method to speed up tooth movement, according to Hatrom et al. research's9. Fu et al. examine variations in Tunçer research's et al. i.e., the tooth was first relocated to the lingual side and just the labial side of the piezocision procedure was used (Fu et al., 2019).

The first clinical trial to examine the degree of mandibular second molar protraction related to piezocision was conducted by Al-Areqi M et al. The purpose of this study was to determine if piezocision affected the rate at which the mandibular second molars protruded as compared to the control group. Results indicated that piezocision increased the second molar's protraction rate during the first two months following surgery, but that it decreased the first molar space closure overall in just one month. Interleukin-1-b levels in GCF rose during the application of orthodontic force for the first 28 days after piezocision (Al-Areqi et al., 2020).

Piezocision and CAD/CAM appliances were used in Charavet et al study's on the acceleration of orthodontic tooth movement. The influence of CAD/CAM tailored orthodontic appliances and piezo decortication on the overall length of orthodontic treatment with special emphasis on the alignment and fine-tuning is highlighted for the first time in this study. The combined use of CAD/CAM and piezocision technology results in a significant reduction in the length of orthodontic treatment. Alignment of the piezocision phase, indeed. However, and much more so than in the case of piezocision, CAD/CAM equipment dramatically shortens the time required for fine-tuning. This study demonstrates that the fastest orthodontic treatment is provided using the CAD/CAM system with piezocision (Charavet et al., 2021).

In a micro-computed tomography study, Patterson et al. investigated the impact of piezocision in relation to orthodontic root resorption with the use of a buccal tipping force for 28 days. The findings revealed that:(1) When combined with orthodontic force, the piezocision causing RAP could promote iatrogenic root resorption. (2) Piezocision should be used carefully because it can biologically harm nearby roots when utilized close to the roots. (3) During thorough therapy, the standard practice of piezocision should be carefully examined. (4) It is important to think about potential uses for amplifying the effects of RAP without causing iatrogenic harm (Patterson et al., 2017). Thus, careful care is needed in minimally invasive surgical treatments used to help accelerate tooth.movement (Fu et al., 2019).

According to Charavet et al., piezocision was more effective on the maxilla than the mandible and had a gradual impact. In patients with minor overcrowding, Charavet et al. also looked into piezocision employing sutures in CAD/CAM tailored orthodontic treatment. Despite the insertion of sutures, spots representing scars could be detected in 66 percent of patients. Prior to utilizing a no-sew surgical technique, scars were observed in 50% of patients in the study by Chavaret et al., with 33% of them being dotted and 17% of them being lined. Sutures thus have a beneficial effect on scar development. Piezocision may continue to be contraindicated in cases when patients have a high gingival smile because minor scars can sometimes linger after the procedure.(Charavet et al., 2019).

3. Conclusion

Piezocision has received substantial research and is more promising for therapeutic applications than traditional corticotomy. There is a high meta-analysis heterogeneity in piezocision, so further research is still needed.

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References

- Aksakalli, S., Calik, B., Kara, B., and Ezirganli, S., 2016, Accelerated tooth movement with piezocision and its periodontal-transversal effects in patients with Class II malocclusion: *The Angle Orthodontist* 86, p. 59–65.
- Al-Areqi, M.M., Abu Alhaija, E.S., and Al-Maaitah, E.F., 2020, Effect of piezocision on mandibular second molar protraction: *The Angle Orthodontist* 90, p. 347–353.
- Alfawal, A.M.H., Hajeer, M.Y., Ajaj, M.A., Hamadah, O., and Brad, B., 2016, Effectiveness of minimally invasive surgical procedures in the acceleration of tooth movement: a systematic review and meta-analysis: *Progress in Orthodontics* 17, p. 33.
- Cassetta, M., Altieri, F., and Barbato, E., 2016, The combined use of corticotomy and clear aligners: A case report: *The Angle Orthodontist* 86, p. 862–870.
- Charavet, C., Lecloux, G., Jackers, N., Albert, A., and Lambert, F., 2019, Piezocision-assisted orthodontic treatment using CAD/CAM customized orthodontic appliances: a randomized controlled trial in adults: *European Journal of Orthodontics* 41, p. 495–501.
- Charavet, C., Van Hede, D., Maes, N., Albert, A., and Lambert, F., 2021, Disentangling the effects of CAD/CAM customized appliances and piezocision in orthodontic treatment: *The Angle Orthodontist* 91, p. 764–771.
- Chen, P.-J., Chang, J.H., Dutra, E.H., Ahmida, A., Nanda, R., and Yadav, S., 2020, The effect of alveolar decortication on orthodontically induced root resorption: *The Angle Orthodontist* 90, p. 524–531.
- Fu, T., Liu, S., Zhao, H., Cao, M., and Zhang, R., 2019, Effectiveness and Safety of Minimally Invasive Orthodontic Tooth Movement Acceleration: A Systematic Review and Meta-analysis: *Journal of Dental Research* 98, p. 1469–1479.
- Gkantidis, N., Mistakidis, I., Kouskoura, T., and Pandis, N., 2014, Effectiveness of non-conventional methods for accelerated orthodontic tooth movement: A systematic review and meta-analysis: *Journal of Dentistry* 42, p. 1300–1319.
- Hatrom, A.A., Zawawi, K.H., Al-Ali, R.M., Sabban, H.M., Zahid, T.M., Al-Turki, G.A., and Hassan, A.H., 2020, Effect of piezocision corticotomy on en-masse retraction: *The Angle Orthodontist* 90, p. 648–654.
- Kernitsky, J.R., Ohira, T., Shosho, D., Lim, J., Bamashmous, A., and Dibart, S., 2021, Corticotomy depth and regional acceleratory phenomenon intensity: *The Angle Orthodontist* 91, p. 206–212.
- Krishnan, V., and Davidovitch, Z., 2006, Cellular, molecular, and tissue-level reactions to orthodontic force: *American Journal of Orthodontics and Dentofacial Orthopedics: Official Publication of the American Association of Orthodontists, Its Constituent Societies, and the American Board of Orthodontics* 129, p. 469.e1–32.
- Li, Z., Zhou, J., and Chen, S., 2021, The effectiveness of locally injected platelet-rich plasma on orthodontic tooth movement acceleration: *The Angle Orthodontist* 91, p. 391–398.
- Librizzi, Z., Kalajzic, Z., Camacho, D., Yadav, S., Nanda, R., and Uribe, F., 2017, Comparison of the effects of three surgical techniques on the rate of orthodontic tooth movement in a rat model: *The Angle Orthodontist* 87, p. 717–724.
- Mheissen, S., Khan, H., and Samawi, S., 2020, Is Piezocision effective in accelerating orthodontic tooth movement: A systematic review and meta-analysis: *PloS One* 15, p. e0231492.
- Patterson, B.M., Dalcı, O., Papadopoulou, A.K., Madukuri, S., Mahon, J., Petocz, P., Spahr, A., and Darendeliler, M.A., 2017, Effect of piezocision on root resorption associated with orthodontic force: A microcomputed tomography study: *American Journal of Orthodontics and Dentofacial Orthopedics: Official Publication of the American Association of Orthodontists, Its Constituent Societies, and the American Board of Orthodontics* 151, p. 53–62.
- Shirude, S.S., Rahalkar, J.S., Agarkar, S., and Manerikar, R., 2018, Interventions for Accelerating Orthodontic Tooth Movement: A Systematic Review: *Journal of Indian Orthodontic Society* 52, p. 265–271.
- Tunçer, N.I., Arman-Özçirpici, A., Oduncuoglu, B.F., Göçmen, J.S., and Kantarci, A., 2017, Efficiency of piezosurgery technique in miniscrew supported en-masse retraction: a single-centre, randomized controlled trial: *European Journal of Orthodontics* 39, p. 586–594.
- Wu, J., Jiang, J.-H., Xu, L., Liang, C., Bai, Y., and Zou, W., 2015, A pilot clinical study of Class III surgical patients facilitated by improved accelerated osteogenic orthodontic treatments: *The Angle Orthodontist* 85, p. 616–624.
- Yi, J., Xiao, J., Li, Y., Li, X., and Zhao, Z., 2017, Efficacy of piezocision on accelerating orthodontic tooth movement: A systematic review: *The Angle Orthodontist* 87, p. 491–498.