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www.jorthodsci.org
DOI:
10.4103/jos.jos_155_25

Does piezocision induce root resorption or periodontal problems in class II patients?: A 2-year follow-up study

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Abstract

OBJECTIVE: This study aimed to evaluate the potential for root resorption and periodontal complications in patients with Class II malocclusion undergoing piezocision-assisted orthodontic treatment over a 2-year follow-up period.

MATERIALS AND METHODS: Twenty patients (11 females, 9 males; mean age: 16.1 ± 2.8 years) requiring bilateral canine distalization and maxillary first premolar extraction were included in this split-mouth study. One quadrant was randomly assigned to undergo piezocision, while the contralateral quadrant served as the control. Panoramic radiographs were utilized to assess root resorption at baseline (T1), and 2 years post-treatment (T2). Additionally, gingival health and tooth mobility scores were evaluated. Statistical analyses were performed using the Wilcoxon signed-rank test.

RESULTS: No clinically significant root resorption was observed in either group. Mild resorption was noted on the upper canine of one patient in the piezocision group, while another patient in the control group exhibited resorption on the upper lateral incisor. Gingival health, and mobility scores decreased from T1 to T2 in both groups, with no statistically significant differences found between the piezocision and control sides. Scar formation on the attached gingiva was observed in one patient following piezocision; however, this was not associated with bone loss or increased periodontal pocket depth.

CONCLUSION: Piezocision-assisted orthodontic treatment did not result in clinically significant root resorption or adverse periodontal outcomes in patients with Class II malocclusion over a 2-year period. These findings support the safety of piezocision as a method for accelerating tooth movement without compromising periodontal health. Further research with larger sample sizes and histological assessments is recommended to validate these results.

Keywords:

Accelerated, periodontal, piezocision, piezosurgery, resorption

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Submitted: 12-Oct-2025
Revised: 18-Dec-2025
Accepted: 07-Jan-2026
Published: 27-May-2026

Introduction

The duration of orthodontic treatment is a significant concern for both patients and clinicians. Prolonged treatment times often lead patients to seek alternative options, such as fixed prosthodontics or restorative procedures, or to postpone orthodontic treatment altogether. To address the issue of prolonged treatment duration, several techniques have been developed and classified in the orthodontic literature as "accelerated tooth movement procedures." Examples include micro-osteoperforations and periodontal ligament distraction.[1-3] Recently, the piezocision technique has been introduced as a minimally invasive alternative.[2] This technique involves surgical injury to the cortical bone using a piezoelectric ultrasonic tool without raising a mucoperiosteal flap. These micro-injuries initiate a transient demineralization process known as the regional acceleratory phenomenon (RAP), which has been found to effectively accelerate tooth movement.[1,2] Consequently, piezocision has been reported

How to cite this article: Aksakalli S, Ezirganli S, Demir E. Does piezocision induce root resorption or periodontal problems in class II patients?: A 2-year follow-up study. J Orthodont Sci 2026;15:11.

to be successful in reducing orthodontic treatment time.[2,4]

Root resorption is considered a common side effect of orthodontic treatment. While most cases are clinically insignificant, severe resorption can compromise the longevity of the dentition.[5] Root resorption is often induced by orthodontic forces and typically progresses asymptomatically. Although routine orthodontic treatment does not usually result in clinically significant root resorption, histological changes are frequently observed. When substantial dental tissue loss occurs, root resorption becomes detectable radiographically.[6] Severe resorption (exceeding one-quarter of the root length) occurs in approximately 1%–5% of orthodontic patients.[7] Such shortening of the roots weakens the dental arch and may increase the risk of orthodontic relapse.[8]

Piezocision, as a surgically invasive procedure involving the periodontium, carries potential risks such as increased tooth mobility or gingival complications due to alterations in the bone and periodontal environment. To date, there is limited long-term data regarding the effects of piezocision on gingival and periodontal health, tooth mobility, stability, or root resorption. Therefore, the objective of this study was to assess root resorption, gingival status, and tooth mobility scores over a 2-year follow-up period following piezocision-assisted orthodontic treatment.

Materials and Methods

This study was designed as a split-mouth randomized clinical trial with two assessment time points: baseline (T1) and 2-year follow-up (T2). As the study is retrospective and based on previously published data, ethical approval was waived. The sample consisted of patients indicated for bilateral maxillary first premolar extraction, and canine distalization due to Class II malocclusion. Inclusion criteria required the absence of systemic disease, and no history of previous orthodontic treatment. Additionally, patients were required to demonstrate good oral hygiene, a probing depth of <3 mm, no periodontal attachment loss, and no radiographic evidence of bone loss.

A split-mouth design was employed, with the experimental quadrant selected via randomization. A total of 30 maxillary canines from 20 patients were included. Consecutive patients meeting the eligibility criteria were invited to participate. Fifteen patients (11 females, 9 males; mean age 16.1 ± 2.8 years) enrolled and completed the follow-up. Hand-wrist radiographs confirmed that all patients had completed their growth and were at the adult stage of skeletal maturation.

In this split-mouth design, both the control (untreated) and experimental (piezocision-treated) sides of each subject contributed data. Within each patient, the experimental quadrant was randomly assigned to receive piezocision using a computer-generated sequence with a 1:1 allocation ratio; the contralateral quadrant served as the control. Outcome scoring was performed by a single calibrated examiner, and repeated measurements were utilized to assess intra-examiner reliability. To preserve the integrity of the double-blind peer review process, institutional identifiers have been omitted. Assuming a conservative effect size of approximately Cohen's $d = 1.2$, a paired-samples t-test with 20 subjects yielded a power greater than 85% ($\alpha = 0.05$). This confirmed that the sample size was sufficient to detect a clinically significant difference in tooth movement velocities attributable to piezocision.

Roth's edgewise brackets (Master Series, American Orthodontics, Sheboygan, Wis) with 0.022-inch slots were utilized. Leveling and alignment were completed prior to canine distalization using elastomeric chains. Piezocision was performed on the experimental side immediately before the initiation of canine distalization. Both sides were distalized concurrently using identical mechanics (approximately 150 g of force via elastomeric chains, changed every 3 weeks) until Class I canine and Class II molar relationships were achieved. The piezocision procedure followed the protocol reported in a similar study.[4] On the control side, distalization commenced simultaneously using the same mechanics. Once Class I canine relationships were obtained, the retraction of the upper incisors was initiated. Orthodontic treatment for all patients was concluded upon the establishment of Class I canine and Class II molar relationships.

Two panoramic radiographs were obtained to assess root resorption: one at the beginning of treatment (T1) and another two years post-piezocision (T2). The primary outcome measure was the radiographic root resorption of maxillary canines, scored on a scale of 0–3 using a modified classification system. Secondary outcomes included the Mühlemann mobility index (0–3/3+) and the Silness-Löe gingival index (0–3) for canines at T1 and T2. Radiographs exhibiting distortion or blurring were excluded from the analysis. The roots of the maxillary canines were examined according to the modified root resorption classification method described by Sharpe *et al*.[9] Panoramic radiographs were used to score the root resorption level for each canine at T1 and T2. The modified root resorption classification is illustrated in Figure 1.

At T1 and T2, mobility scores and gingival indices for the canines were evaluated. Mobility was assessed using Mühlemann's index: 0 = no mobility; 1 ≥ 0.5 mm and <1 mm buccolingually; 2 ≥ 1 mm and <2 mm buccolingually; 3 ≥ 2 mm buccolingually; and 3+ = both vertical and buccolingual mobility (Mühlemann, 1967). Gingival health was assessed using the Silness and Löe Gingival Index, which scores the marginal and interproximal tissues on a scale of 0 to 3: 0 = Normal gingiva; 1 = Mild inflammation; 2 = Moderate inflammation; 3 = Severe inflammation (Löe and Silness, 1963).

Statistical analysis revealed a non-normal data distribution; therefore, the Wilcoxon signed-rank test was employed to compare the two groups. Initial measurements were repeated after 1 week, and the assessment of root resorption was performed by a single blinded examiner. All statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS version 20, SPSS Inc., Chicago, IL).

Results

Reliability analysis yielded coefficients close to 1.00, indicating high intra-examiner agreement. Regarding root resorption, no statistically significant difference was observed between the piezocision and control groups [Table 1]. Only one patient exhibited a score of 1 (mild resorption) for the upper canine on the piezocision side. In another patient, root resorption was detected on an upper lateral incisor, although this study specifically evaluated canines. Notably, this lateral incisor was located on the control side [Figure 2]. Twenty patients (40 canines) completed the 2-year follow-up. Canine resorption at T2 occurred in 1/15 (6.7%; 95% CI 1.2%–29.8%) on the piezocision side and 0/15 (0%; 95% CI 0 and –20.4%) on the control side.

At T2, the mean mobility score was 0.30 (95% CI 0.23–0.37) for the piezocision side and 0.20 (0.15–0.25) for the control side. The mean gingival index was 0.30 (0.26–0.34) for the piezocision side and 0.40 (0.32–0.48) for the control side. No statistically significant within-patient differences were detected for either parameter. One patient presented with a localized mucogingival scar at the piezocision site, which was not associated with bone loss or increased pocket depth.

Mobility scores for the canines decreased in both groups from T1 to T2 [Table 2]. At the 2-year follow-up, no significant difference was found between the groups. Similarly, gingival health scores improved (decreased) in both groups from T1 to T2, with no significant difference observed between the groups at T2 [Table 3]. Only one patient exhibited a visible scar on the attached gingiva following piezocision [Figure 3].

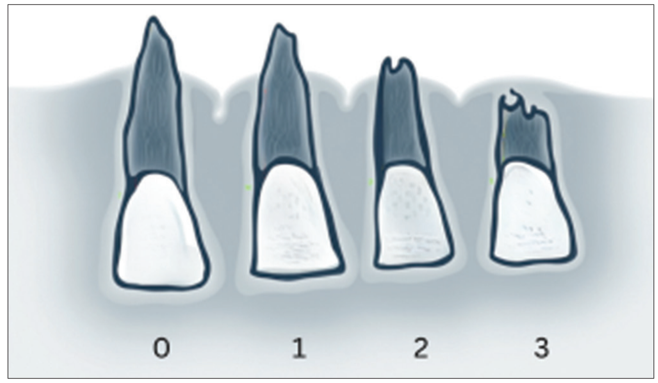

Figure 1: The modified root resorption classification method. 0: no visible root resorption 1: mild resorption, the apex is blunted or diffuse. 2: moderate resorption, the root apex disappears and the contour is sometimes not smooth 3: severe resorption, root resorption is more than one-quarter of the root, the root reveals excessive blunting

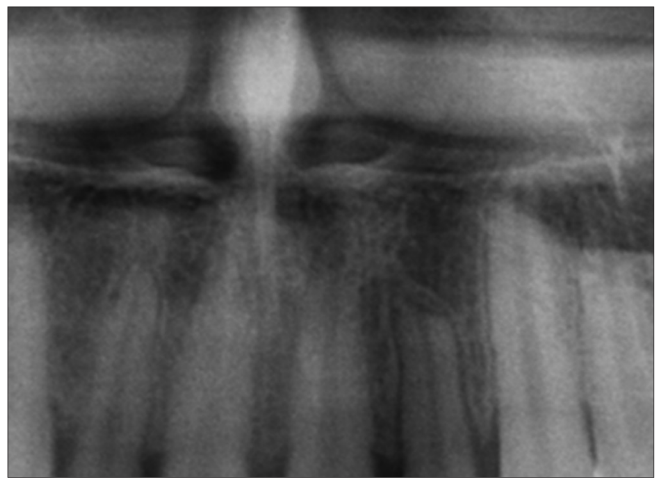

Figure 2: Resorption on upper lateral tooth

Figure 3: Scar on attached gingiva

Discussion

Periapical and panoramic radiographs are the standard imaging modalities for evaluating root resorption in orthodontics. In the present study, panoramic radiographs were selected as they provide a reliable method for comparing changes over time and facilitate

Table 1: Root resorption scores for canines

	Teeth	2-year follow-up score
Piezocision group	1	0
	2	0
	3	0
	4	0
	5	0
	6	1
	7	0
	8	0
	9	0
	10	0
	11	0
	12	0
	13	0
	14	0
	15	0
	16	0
	17	0
	18	0
	19	0
	20	0
Control group	1	0
	2	0
	3	0
	4	0
	5	0
	6	0
	7	0
	8	0
	9	0
	10	0
	11	0
	12	0
	13	0
	14	0
	15	0
	16	0
	17	0
	18	0
	19	0
	20	0

Table 2: Mobility scores

	Before treatment	2-year follow-up
	Mean±SD	Mean±SD
Piezocision group	1.2±0.60	0.3±0.12
Control group	1.5±0.56	0.2±0.09

SD: Standard deviation

Table 3: Gingival index scores

	Before treatment	2-year follow up
	Mean±SD	Mean±SD
Piezocision group	1.2±0.70	0.3±0.08
Control group	1.2±0.44	0.4±0.14

SD: Standard deviation

the assessment of root length changes across the entire dentition. A distinct advantage of panoramic radiography is its ability to provide comprehensive information regarding the teeth, jaws, and dentoalveolar bone in a single film.[10] While periapical films using the paralleling technique offer higher resolution, they carry a risk of geometric distortion that can complicate longitudinal comparisons between T1 and T2. Furthermore, obtaining a full-mouth series of periapical films in addition to panoramic radiographs would have subjected patients to unnecessary radiation exposure.

The potential use of cone-beam computed tomography (CBCT) was also considered. Our clinic strictly adheres to the guidelines established by the SEDENTEXCT project, which govern the safe and effective use of CBCT in dentomaxillofacial radiology. These guidelines are endorsed by our university's Ethics Committee. Since 2008, the SEDENTEXCT Project in Europe, supported by the Euratom Seventh Framework Programmed, has promoted the ALARA (As Low as Reasonably Achievable) principle. According to these guidelines, "CBCT should not be selected unless a history and clinical examination have been performed; routine or screening imaging is unacceptable." While CBCT usage varies globally, its application in Europe is typically reserved for specific indications such as cleft palate assessment, surgical planning for orthognathic cases, and the evaluation of impacted teeth.[11,12] In the present study, there was no clinical indication necessitating CBCT, a decision further supported by the benign 2-year outcomes. Recent literature also emphasizes that CBCT should not be used indiscriminately in orthodontics[13] and should be employed only when it significantly influences diagnosis or treatment planning.[14]

Although orthodontic therapy in this study did not lead to clinically significant radiographic root resorption, subclinical histological changes may have occurred. It is important to acknowledge that no histological or microscopic assessments were performed in this study.

A relationship between accelerated orthodontic techniques and root resorption has been hypothesized. However, corticotomy-assisted orthodontic treatment has been reported to present little to no increased risk of root resorption. The biological mechanism underlying this technique involves localized selective alveolar decortication combined with orthodontic force, which induces rapid bone remodeling within the marrow spaces. This process reduces hyalinization of the periodontal ligament, and eliminates the lag phase typically seen in orthodontic tooth movement.[15] One study[16] even reported less resorption with corticotomy-assisted treatment compared to conventional methods.[17]

Conversely, Patterson *et al*.[18] suggested an increased risk of root resorption following piezocision; however, their findings were based on a short 4-week observation period and utilized different biomechanics. Furthermore, debates regarding the statistical interpretation of that study should be considered.[19] In longitudinal studies such as ours, it is also relevant to note that minor resorption craters often undergo natural repair over time.[20]

In the current study, no significant root resorption was observed in either group, and no difference was found between the piezocision and control sides. One patient exhibited root resorption in an upper lateral incisor on the control side. This may be attributed to the inherent susceptibility of maxillary lateral incisors to resorption,[21] excessive orthodontic forces,[19] or individual biological factors such as genetics and systemic health.[21-23]

The method employed for detecting root resorption in this study is consistent with previous research and is considered accurate for use with panoramic or periapical radiographs.[24,25] The modified root resorption classification used here aligns with the methodology of Jiang *et al*.,[9] which focuses on alterations in apical morphology. This method has also been utilized to assess endemic features of resorption using panoramic radiographs,[18] with findings consistent with studies utilizing periapical films.[25]

Corticotomy-assisted orthodontics has generally been demonstrated to be safe for periodontal health. Evaluations of probing depth, gingival recession, and attachment levels have shown no significant differences between accelerated, and conventional treatment groups. In the present study, the Gingival Index was utilized, and no significant inter-group differences were observed, aligning with previous findings.[12,26,27] All patients received oral hygiene instruction. Following piezocision, brushing in the canine region may be compromised due to transient tenderness, potentially explaining the slight increase in gingival scores at T1. One patient developed a scar on the attached gingiva following piezocision; however, this was not associated with bone loss, increased pocket depth, or patient discomfort. Scar formation in the oral cavity can be influenced by various factors, including bacterial colonization, the moist environment, and salivary growth factors.[26] Mobility scores decreased from T1 to T2 in both groups, likely reflecting the cessation of active orthodontic forces. Our results agree with other corticotomy studies.[16,28,29]

We explicitly acknowledge several limitations: (i) the modest sample size, which is typical for a single-center split-mouth trial; (ii) the low event rate for radiographically visible resorption; and (iii) the lower sensitivity of panoramic radiographs compared to periapical films or CBCT. These factors may widen confidence intervals and limit definitive inferences regarding minor differences. Nonetheless, within these constraints, no clinically significant adverse effects attributable to piezocision were detected over the 2-year period. Future studies with larger sample sizes and, where ethically justified, higher-resolution imaging are warranted.

Conclusion

The findings of this study suggest the following:

1. No clinically significant root resorption was observed in the canines following piezocision-assisted orthodontic treatment over a 2-year follow-up period.
2. Gingival health and mobility scores improved (decreased) from baseline (T1) to the 2-year follow-up (T2) in both groups, with no significant differences observed between the piezocision and control sides.
3. These results support the long-term safety of piezocision regarding root integrity and periodontal health.

Institutional review board statement

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee (The Ethics Committee at ……. University, file number: 2013/107) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent statement

Informed consent was obtained from all subjects involved in the study.

Data availability

All data generated or analyzed during this study are included in this published article.

Authors contributions

S.A. (Aksakallı): Conceptualization, Methodology, Software, Formal Analysis, Writing – Original Draft.
Ş.E. (Ezirganlı): Data Curation, Validation, Investigation, Resources.
E.D. (Demir): Writing – Review & Editing, Supervision, Project Administration.

Financial support and sponsorship

No funding was received for this study.

Conflict of interest

The authors declare that they have no financial or non-financial conflicts of interest related to this study.

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