GMR
The Original

EFFECT OF PIEZOCISION ON MANDIBULAR ANTERIOR ALIGNMENT DURING FIXED ORTHODONTIC TREATMENT: A SYSTEMATIC REVIEW AND META-ANALYSIS OF RANDOMIZED CONTROLLED TRIALS

Dr. Akshaya. K[1], Dr. Sangeetha Duraisamy[2], Dr. Ravi Kannan[3]

[1]Postgraduate Student, Head Department of Orthodontics and Dentofacial Orthopaedics, SRM Dental college, Bharathi Salai, Ramapuram,
[2]Professor, Head Department of Orthodontics and Dentofacial Orthopaedics, SRM Dental college, Bharathi Salai, Ramapuram,
[3]Dean, Head Department of Orthodontics and Dentofacial Orthopaedics, SRM Dental college, Bharathi Salai, Ramapuram, Chennai-600089
***CORRESPONDING AUTHOR:** Dr. Akshaya; Email: akshayakothandaraman@gmail.com

ABSTRACT
Introduction: Piezocision is a minimally invasive surgical technique proposed to accelerate orthodontic tooth movement. However, evidence regarding its effect on the alignment of mandibular anterior teeth remains inconsistent.
Objective: To evaluate the effect of piezocision on the time required to achieve mandibular anterior alignment during fixed orthodontic treatment compared with orthodontic treatment without piezocision.
Materials and Methods: A systematic review and meta-analysis was conducted in accordance with the PRISMA 2020 guidelines. PubMed/MEDLINE, Cochrane CENTRAL, ScienceDirect, Embase/Ovid, and Google Scholar were searched from inception to January 30, 2026. Randomized controlled trials evaluating piezocision assisted fixed orthodontic treatment for mandibular anterior crowding were considered eligible. Two reviewers independently performed study selection and data extraction, and risk of bias was assessed using the Cochrane Risk of Bias 2 tool. Where sufficiently comparable data were available, continuous outcomes were synthesized using mean differences with 95% confidence intervals (CIs) under an inverse-variance random-effects model.
Results: Six randomized controlled trials were included in the systematic review. Four studies contributed to the meta-analysis of time required to achieve mandibular anterior alignment. The pooled analysis suggested a reduction in alignment time favouring piezocision (MD −46.29 days, 95% CI −76.12 to −16.45; $P = 0.002$); however, substantial heterogeneity was observed ($I^2 = 93\%$), limiting confidence in the consistency and generalizability of this estimate.
Conclusion: Piezocision may accelerate the alignment of mandibular anterior teeth during fixed orthodontic treatment. However, substantial heterogeneity among studies indicates considerable uncertainty regarding the magnitude and consistency of this effect.

KEYWORDS: Piezocision; orthodontic tooth movement; mandibular anterior crowding; dental alignment; accelerated orthodontics; systematic review; meta-analysis

INTRODUCTION
Over the past decade, advances in orthodontic technology have increased the expectations of both clinicians and patients for more efficient treatment outcomes, including the duration of active orthodontic treatment.[1] Prolonged treatment may increase the risk of enamel decalcification, gingival inflammation, root resorption and patient dissatisfaction, affecting treatment acceptance and compliance.[1,2] Orthodontic tooth movement is relatively slow and varies considerably according to the type of tooth movement, force system, biological characteristics and measurement method.[3–5]
Consequently, various approaches have been investigated to accelerate orthodontic tooth movement and reduce treatment duration. These include surgical and minimally invasive techniques such as corticotomy, corticision, periodontally accelerated osteogenic orthodontics, micro-osteoperforation (MOP) and piezocision, as well as non-surgical approaches such as low level laser therapy and mechanical vibration.[6-10] Among these approaches, piezocision has attracted considerable interest because it aims to enhance orthodontic tooth movement while avoiding the extensive flap elevation associated with conventional corticotomy procedures.[10]
Piezocision is a minimally invasive corticotomy-assisted orthodontic technique involving small soft-tissue incisions through which a piezoelectric instrument is used to create selective cortical bone injuries.[10,11] The procedure has been proposed to accelerate orthodontic tooth movement by inducing a transient regional bone-remodelling response, commonly associated with the regional acceleratory phenomenon.[11,12]
Mandibular anterior crowding is one of the most common orthodontic problems encountered in clinical practice.[13] The initial alignment phase is an essential component of fixed orthodontic treatment and is influenced by several factors, including the severity of crowding, periodontal characteristics, initial tooth position, archwire sequence,

bracket system and the biomechanics used during treatment.[13] The duration of this phase may therefore vary considerably between patients.[14-16]
Studies have reported faster reduction in mandibular anterior crowding and shorter time to achieve alignment following piezocision, whereas others have not demonstrated a statistically significant advantage over conventional orthodontic treatment.[17–22] Differences in initial crowding severity, patient characteristics, orthodontic appliance systems and mechanics, piezocision protocols, incision characteristics, and outcome definitions may contribute to the variability in reported findings.

Evidence specifically addressing the effect of piezocision on mandibular anterior alignment during fixed orthodontic treatment remains limited and heterogeneous. Furthermore, differences in surgical protocols and outcome definitions may limit direct comparison among studies. Therefore, this systematic review and meta-analysis evaluated whether adjunctive piezocision reduces the time required to achieve mandibular anterior alignment during fixed orthodontic treatment compared with treatment without piezocision.

METHODOLOGY

The research was conducted in accordance with the PRISMA 2020 guidelines. The research question was formulated according to the PICOS framework: "In patients undergoing fixed orthodontic treatment with mandibular anterior crowding, does adjunctive piezocision reduce the time required to achieve mandibular anterior alignment compared with fixed orthodontic treatment without piezocision?" (Table 1).

Table 1. PICOS framework for the research question

Population	Intervention	Control	Outcome	Study design
Patients undergoing fixed orthodontic treatment with mandibular anterior crowding	Piezocision assisted orthodontic treatment	Conventional fixed orthodontic treatment without piezocision or with any non-piezocision comparator	Time required to achieve mandibular anterior alignment	randomized controlled trials

Inclusion Criteria:
Studies were eligible for inclusion if they were randomized controlled trials evaluating the effect of piezocision on the time required to achieve mandibular anterior alignment in human participants undergoing fixed orthodontic treatment for mandibular anterior crowding. Studies were required to report at least one clinically relevant outcome related to mandibular anterior alignment, including time required to achieve alignment. Studies reporting secondary outcomes, including changes in Little's Irregularity Index (LII), rate of alignment or decrowding, periodontal parameters, or patient-reported outcomes, were also eligible. Only full-text articles published in peer-reviewed journals and available in English were included**.**

Exclusion criteria
Studies were excluded if they were non randomized controlled trials, observational or retrospective studies, case-control studies, case reports, case series, in vitro or animal studies, systematic reviews, meta-analyses, narrative reviews, scoping reviews, conference abstracts, editorials, letters to the editor or expert opinions. Studies evaluating orthodontic acceleration techniques other than piezocision were excluded unless a separate piezocision intervention group was available for comparison. Studies without an appropriate conventional orthodontic treatment comparator or those that did not report at least one relevant outcome were excluded. Studies in which piezocision was combined with other acceleration interventions that prevented the independent effect of piezocision from being determined were excluded. Duplicate publications and studies for which the full text was unavailable were also excluded.

Search Strategy:
A comprehensive electronic literature search was conducted in PubMed/MEDLINE, Cochrane CENTRAL, ScienceDirect, Embase/Ovid, and Google Scholar from database inception to January 30, 2026. The search strategy was developed using keywords and controlled vocabulary related to the intervention, orthodontic treatment, and mandibular anterior alignment. The primary search concepts included piezocision, piezoincision, piezo-assisted corticotomy, orthodontic treatment, fixed orthodontic appliances, alignment, decrowding, mandibular anterior teeth, and lower anterior crowding. Boolean operators AND and OR were used to combine the search terms, and appropriate truncation and database-specific search syntax were applied where applicable. The complete search strategies for each database are presented in Table 2. The reference lists of all included studies and relevant systematic reviews were also screened manually to identify additional potentially eligible studies. No restrictions were applied based on publication date.

Table 2. Database specific search strategy

Database	Platform	Search strategy
MEDLINE	PubMed	("piezocision" OR "piezoincision" OR "piezo-assisted corticotomy" OR "piezocision corticotomy") AND (orthodontic OR "fixed orthodontic treatment"

		OR braces) AND alignment OR "tooth movement" OR "alignment efficiency") AND (mandibular OR mandible OR "lower arch")
CENTRAL	Cochrane	("piezocision" OR "piezoincision" OR "piezo-assisted corticotomy" OR "piezocision corticotomy") AND (orthodontic OR "fixed orthodontic treatment" OR braces) AND (alignment OR "tooth movement" OR "alignment efficiency") AND (mandibular OR mandible OR "lower arch")
ScienceDirect	Elsevier	(Piezocision) AND (mandibular anteriors) AND (rate of alignment)
Embase	Ovid	(Piezocision)AND (alignment) AND (mandibular anterior OR lower anterior)
Google Scholar	Google	("Piezocision") AND ("alignment" OR "alignment efficacy") AND ("mandibular anteriors" OR "lower anterior crowding")

Study Selection:

A total of 121 records were identified through the electronic database search. After removal of 8 duplicate records, 113 records underwent title and abstract screening. Two reviewers independently screened the titles and abstracts based on the predefined eligibility criteria and 106 studies that did not meet the inclusion criteria were excluded. The full texts of the 7 potentially eligible studies were subsequently retrieved and assessed by the two reviewers for final eligibility. The reference lists of the included studies were also screened, where applicable, to identify any additional eligible studies. One potentially eligible study was excluded because arch-specific outcome data for the mandibular anterior teeth could not be extracted. Charavet et al. evaluated piezocision-assisted orthodontic treatment involving both maxillary and mandibular anterior teeth; however, separate mandibular data were not reported.[23] Throughout the selection process, any disagreements between the reviewers were resolved through discussion and consensus. Study selection process and the number of records identified, screened, assessed for eligibility, and included in the systematic review are presented in the PRISMA flow diagram (Figure 1).

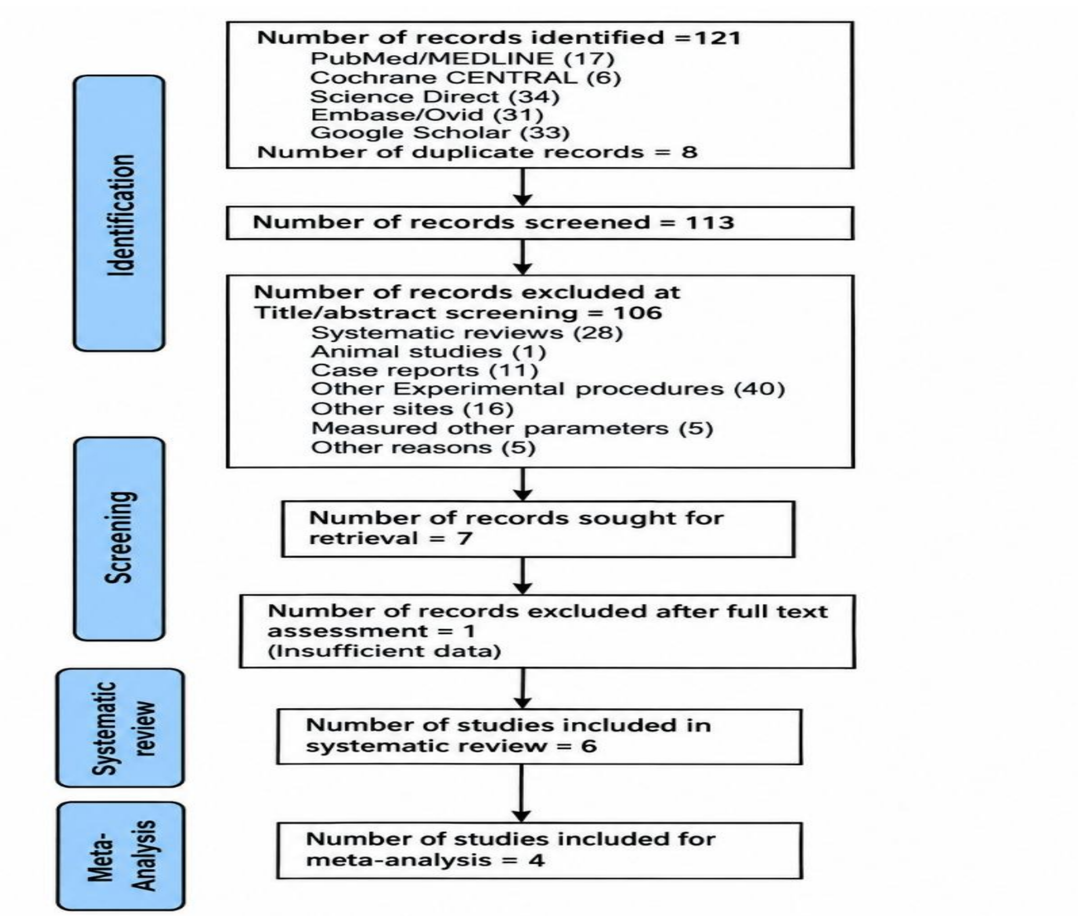

Figure 1. PRISMA flow diagram for studies retrieved through the searching and selection process

Characteristics of included studies

Six randomized controlled trials published between 2017 and 2025 were included in the systematic review, comprising a total of 186 participants. Five studies used a two-arm design, four of them comparing piezocision assisted orthodontic treatment with conventional orthodontic treatment and one with micro-osteoperforation. One study used a three-arm design comparing piezocision, micro-osteoperforation, and conventional orthodontic treatment. The sample sizes ranged from 20 to 44 participants, and the reported mean ages ranged from approximately 17 to 30 years. Baseline mandibular anterior crowding, assessed using LII, varied across studies, with reported mean values ranging from approximately 5.6 to 11.7 mm; the Rao et al. study included participants with moderate-to-severe crowding (LII >5 mm), although group-specific baseline means were not reported. The piezocision protocols also differed between studies, including conventional flapless piezocision and a 3D-guided piezocision approach. Outcome assessment varied across the studies and included time required to achieve mandibular anterior alignment, serial changes in LII, rate of mandibular anterior alignment or decrowding, periodontal parameters, and patient-reported comfort and oral-health-related quality of life. The criterion used to define completion of alignment was also not uniform, with some studies using an LII threshold of ≤1 mm and others using ≤2 mm. Detailed characteristics of the included studies are presented in Table 3.

Table 3. Characteristics of the included randomized controlled trials evaluating the effect of piezocision on mandibular anterior alignment and levelling.

Author, year & study design	**Study groups**	**Mean age (years)**	**Mean LII at baseline (mm)**	**Follow up time**	**Outcomes (primary & secondary)**
Flavio Uribe, 2017 [22] (Two-arm parallel-group randomized clinical trial)	**Intervention:** Flapless piezocision assisted orthodontic treatment (n=16) (10 females & 6 males) **Control:** conventional orthodontic treatment (n=13) (7 females & 6 males)	**Intervention:** 30±12.5 **Control:** 29.4±9.3	**Intervention:** 6.73±1.99 **Control:** 8.32±2.29	Until LII ≤2 mm	**Primary:** Overall alignment time of mandibular anteriors **Secondary:** Changes in LII measured during alignment.
Gibreal et al., 2019 [18] (two-arm, parallel-group randomized controlled trial)	**Intervention:** Flapless piezocision assisted orthodontic treatment (n=17). (9 females & 8 males) **Control:** conventional orthodontic treatment (n=17) (9 females & 8 males)	**Intervention:** 20.29 ± 1.79 **Control:** 20.35 ± 2.17 **Overall:** 20.32 ± 1.96**.**	**Intervention:** 11.57 ± 1.19 **Control:** 11.32 ± 0.97	Until LII ≤1 mm	**Primary:** Overall alignment time of mandibular anteriors **Secondary:** Changes in LII measured monthly during alignment.
Gibreal et al., 2022[19] (two-arm, parallel-group randomized controlled trial)	**Intervention:** 3D-guided piezocision-assisted orthodontic treatment (n=18). (10 females & 8 males) **Control:** Conventional orthodontic treatment (n=17). **(**9 females & 7 males)	**Intervention:** 20.86±1.98 **Control:** 21.27±1.87 **Overall:** 21.03 ± 1.96.	**Intervention:** **11.59±0.69** Control: **11.66±1.17**	Until (LII ≤1 mm)	**Primary:** Overall alignment time of mandibular anteriors. **Secondary:** LII changes at T0, 1 month, 2 months, and completion of alignment.
Kilinc and Baka, 2023 [21]	**Intervention:** Flapless piezocision-	**Piezocision:** 16.99 ± 1.74 **MOP:**	**Piezocision:** 8.20 ± 1.52 **MOP:**	16 weeks	**Primary:** Rate of mandibular anterior levelling and alignment

(Three-arm randomized controlled clinical trial)	assisted orthodontic treatment (n=15) (9 females & 6 males) Flapless Micro-osteoperforation assisted orthodontic treatment (n=14) (females & 5 males) **Control:** Conventional orthodontic treatment. (n=15), (7 females & 8 males)	17.51 ± 2.43 **Control**: 17.40 ± 2.16**.**	7.71 ± 1.40 **Control:** 6.93 ± 1.25		measured by changes in LII. **Secondary:** Periodontal parameters and patient comfort (VAS scores & OHIP-14 scores)
Rao et al., 2024 [20] (Randomized comparative clinical study)	**Piezocision:** Flapless piezocision assisted orthodontic treatment. (n=12) **Micro-osteoperforation:** Flapless micro-osteoperforation assisted orthodontic treatment (n=12) (16 females & 8 males overall)	overall mean age: 19.6 ± 2.6 years; group-wise mean ages not reported.	Moderate-to-severe crowding with LII >5 mm**.** Exact baseline group means were not reported.	Until LII ≤1 mm	**Primary:** Rate of lower anterior decrowding. **Secondary:** Total alignment/decrowding time and serial changes in LII.
Kumar et al., 2025 [17] (Two-arm randomized controlled clinical trial)	**Intervention:** Flapless piezocision assisted orthodontic treatment (n=10) **Control:** Conventional orthodontic treatment (n=10) Individual gender count was not mentioned.	**Piezocision:** 23.80 ± 2.044 **Control**: 24.00 ± 2.749	**Piezocision:** 5.60 ± 0.944 **Control:** 5.90 ± 0.994	Until LII ≤2 mm	**Primary outcome:** Time required for complete mandibular anterior alignment **Secondary outcome:** Change in LII

Risk of Bias:

Two reviewers independently assessed the risk of bias of the included randomized controlled trials using the Cochrane Risk of Bias 2 (RoB 2) tool. Assessment was performed across the five domains: bias arising from the randomization process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in measurement of the outcome, and bias in selection of the reported result. Disagreements were resolved through discussion and consensus. Risk-of-bias judgements were considered when interpreting the findings of the meta-analysis.

The RoB 2 assessment indicated that five of the six included studies had some concerns regarding overall risk of bias, while one study (Puneeth Kumar et al.) was judged to have a high overall risk of bias. The main concerns involved the randomization process, deviations from intended interventions, and selection of the reported result**.** All studies were judged to have a low risk of bias for missing outcome data and measurement of the outcome**.** Detailed domain-level judgements are presented in Figure 2.

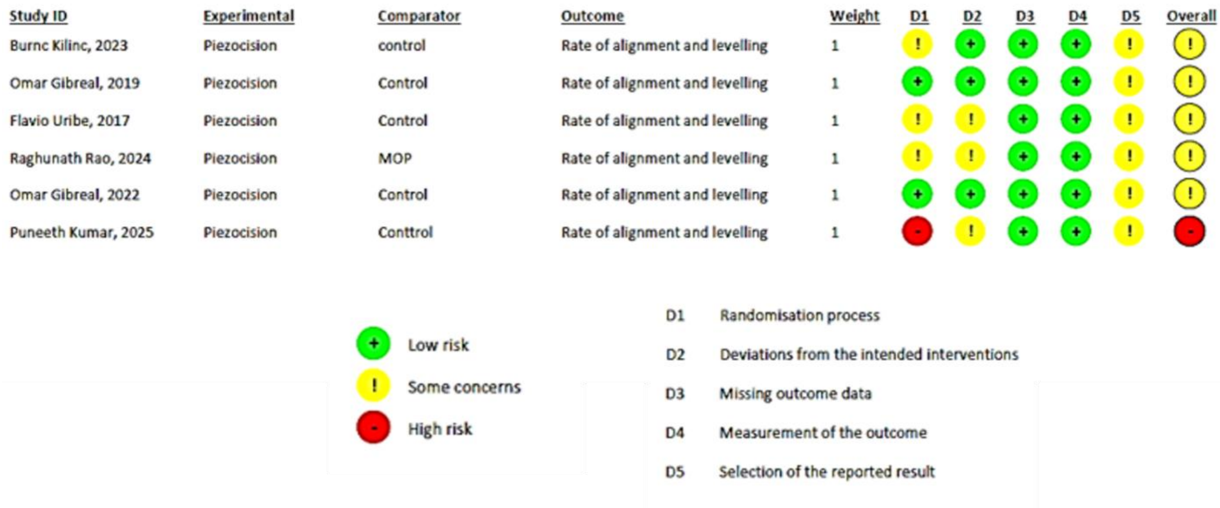

Figure 2. Risk of bias assessment of the included RCTs using the Cochrane Risk of Bias 2 (RoB 2) tool across five domains

Data Extraction:
Data were independently extracted by two reviewers using a standardized, predefined data extraction form. The following information was extracted from each included study: first author and year of publication, study design, sample size, participant characteristics, severity of mandibular anterior crowding, duration of follow-up, and outcome assessment methods.
The clinical outcomes extracted included data related to the alignment of mandibular anterior crowding and rate of alignment. For continuous outcomes, the mean values and measures of variability, preferably standard deviations, were recorded for each intervention and comparator group. Any discrepancies between the two reviewers during data extraction were resolved through discussion and consensus. The outcome data of the included studies are presented in Table 5.

Table 5. Data extracted from the included randomized controlled trials evaluating the effect of piezocision on mandibular anterior alignment.

Study	Outcome reported	Intervention sample (n)	Intervention mean ± SD	Control sample (n)	Control mean ± SD	Quantitative synthesis
Uribe et al., 2017	mandibular anterior alignment time (days)	16	102.13 ± 4.73	13	112.00 ± 46.22	included
Gibreal et al., 2019	mandibular anterior alignment time (days)	17	53.53 ± 12.50	17	131.40 ± 38.50	included
Kilinc & Baka, 2023	Reduction in mandibular anterior LII over 16 weeks (mm)	15	7.60 ± 1.55	15	5.95 ± 1.28	not pooled with alignment time
Rao et al., 2024	Mean rate of LII change (mm/month)	12	4.38 ± 0.61	12	3.82 ± 0.47	not pooled with alignment time
Gibreal et al., 2022	mandibular anterior alignment time (days)	18	61.90 ± 12.52	17	129.11 ± 35.53	included
Kumar et al., 2025	mandibular anterior alignment time (days)	10	104.50 ± 4.972	10	131.60 ± 5.103	included

Effect of piezocision on the time required to achieve mandibular anterior alignment

Qualitative synthesis
Six randomized controlled trials evaluated the effect of piezocision on mandibular anterior alignment, although the interventions, comparators, alignment criteria, and outcome measures varied across studies. [17-22]
Uribe et al. (2017) reported a mean alignment time of 102.13 days in the piezocision group compared with 112.00 days in the conventional orthodontic treatment group, with no statistically significant between-group difference.[22]
Gibreal et al. (2019) reported substantially shorter alignment time with flapless piezocision, with mean times of

53.53 days and 131.40 days in the piezocision and conventional treatment groups, respectively.[18] The piezocision group also demonstrated greater reduction in mandibular anterior irregularity at one month.[18]

Similarly, Gibreal et al. (2022) reported shorter alignment time with three-dimensional-guided piezocision than with conventional orthodontic treatment (61.90 ± 12.52 versus 129.11 ± 35.53 days; $P < 0.0001$), together with greater reduction in LII at one month.[19] Kilinc and Baka (2023) compared piezocision, micro-osteoperforation (MOP), and conventional orthodontic treatment and evaluated changes in LII over 16 weeks rather than time to a predefined alignment endpoint.[21] The reduction in LII was greater in the piezocision group than in the conventional treatment group (7.60 ± 1.55 versus 5.95 ± 1.28 mm), although this outcome was not directly comparable with the alignment-time outcomes.[21]

Rao et al. (2024) compared piezocision with MOP in patients with moderate-to-severe mandibular anterior crowding. [20] The mean rate of reduction in irregularity was 4.38 ± 0.61 mm/month with piezocision and 3.82 ± 0.47 mm/month with MOP, with a statistically significant between-group difference. [20] Kumar et al. (2025) reported a mean alignment time of 104.50 days with piezocision compared with 131.60 days with conventional orthodontic treatment. [17] Although alignment was achieved earlier in the piezocision group, LII values at completion of alignment were similar between groups. [17]

Overall, the four studies reporting alignment time showed point estimates favouring piezocision, whereas the studies assessing changes or rates of LII provided additional but distinct evidence regarding early reduction in mandibular anterior irregularity. [17-22] Because alignment time and changes in LII represent different outcomes, these measures were considered separately in the synthesis.

Quantitative synthesis

Study or Subgroup	Piezocision			Control			Mean Difference	Mean Difference
	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
Uribe et al., 2017	102.13	34.7	16	112.00	46.2	13	21.7%	-9.87 [-40.22, 20.48]
Gibreal et al., 2019	53.53	12.5	17	131.40	38.5	17	25.1%	-77.87 [-97.11, -58.63]
Gibreal et al., 2022	61.90	12.5	18	129.11	35.5	17	25.4%	-67.21 [-85.06, -49.36]
Kumar et al., 2025	104.50	4.97	10	131.60	5.1	10	27.8%	-27.10 [-31.52, -22.68]
Total (95% CI)			**61**			**57**	**100.0%**	**-46.29 [-76.12, -16.45]**

Heterogeneity: $Tau^2 = 828.14$; $Chi^2 = 43.44$, df = 3 (P = 0.0000); $I^2 = 93\%$

Test for overall effect: Z = -3.04 (P = 0.00236)

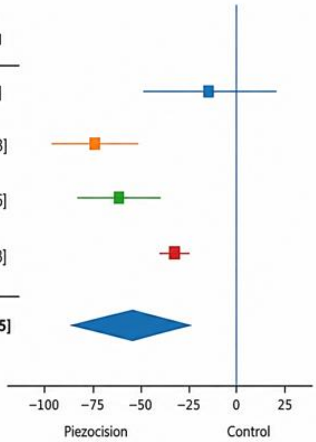

Figure 3. Forest plot of the effect of piezocision on time required to achieve mandibular anterior alignment. Mean differences were calculated as alignment time in the piezocision group minus alignment time in the comparator group; negative values favour piezocision. The pooled estimate was calculated using a random-effects model.

Four randomized controlled trials reporting the time required to achieve mandibular anterior alignment were included in the quantitative synthesis. As the outcome was reported as a continuous variable in days, the treatment effect was expressed as a mean difference (MD) with 95% confidence interval (CI). The MD was calculated as the mean alignment time in the piezocision group minus that in the comparator group; therefore, negative values indicated a shorter time to achieve alignment with piezocision. An inverse-variance random-effects model was used to account for anticipated clinical and methodological variability among the included studies.

All four studies showed point estimates favouring piezocision, although the confidence interval for the study by Uribe et al. crossed the line of no effect.

The pooled estimate corresponded to a mean difference of approximately 46 days in favour of piezocision (MD = −46.29 days, 95% CI −76.12 to −16.45; Z = −3.04; P = 0.002); however, substantial between-study heterogeneity and differences in alignment thresholds ($\tau^2 = 828.14$; $\chi^2 = 43.44$, df = 3; $P < 0.001$; $I^2 = 93\%$), substantially limit its interpretation. The individual estimates ranged from a relatively small reduction of approximately 10 days in the study by Uribe et al. to reductions of approximately 78 days in the studies by Gibreal et al. This variability indicates that the pooled estimate should be interpreted cautiously and should not be considered evidence of a uniform 46-day reduction in alignment time across clinical settings.

The observed heterogeneity may reflect differences in baseline crowding severity, orthodontic treatment protocols, patient characteristics, piezocision techniques, and, importantly, the criteria used to define completion of alignment. In particular, the included studies did not use a uniform alignment endpoint, with some defining completion as an LII ≤1 mm and others as an LII ≤2 mm. Consequently, although the pooled analysis demonstrates a statistically significant overall effect favouring piezocision, the substantial heterogeneity and differences in outcome definition limit the certainty and generalizability of the pooled magnitude of effect.

DISCUSSION

The present systematic review evaluated whether adjunctive piezocision accelerates mandibular anterior alignment during fixed orthodontic treatment. Six randomized controlled trials were included, of which four provided data for the meta-analysis of alignment time. The pooled analysis demonstrated a statistically significant reduction in alignment time with piezocision; however, the substantial heterogeneity between studies limits confidence in the magnitude and generalizability of the pooled estimate.

The direction of effect was consistent across the four studies reporting alignment time, although the magnitude of acceleration varied considerably. This variability is likely to reflect differences in baseline crowding severity, orthodontic mechanics, patient characteristics, piezocision protocols, and definitions of alignment completion.[17–22] Importantly, the alignment endpoint was not standardized: Gibreal et al. defined completion as an LII ≤1 mm, whereas Uribe et al. and Kumar et al. used an LII ≤2 mm.[17–19,22] Consequently, the pooled estimate represents effects across study-specific operational definitions rather than a completely standardized clinical endpoint.

The findings based on LII should be interpreted separately from alignment-time outcomes. Changes in LII quantify the extent or rate of reduction in anterior irregularity over a specified period, whereas time to a predefined LII threshold represents the duration required to reach a particular clinical endpoint. These outcomes are related but not interchangeable. The available studies generally reported greater early reductions in LII with piezocision, although findings were not completely consistent. [17–21] Therefore, evidence for an effect on early irregularity reduction should not be interpreted as direct evidence of a corresponding reduction in total orthodontic treatment duration.

Influence of the surgical protocol

Variation in the delivery of piezocision is another potential contributor to the observed heterogeneity. The included studies differed in the number, location, extent and depth of cortical incisions, and one study used three-dimensional surgical guidance. Although differences in cortical penetration could theoretically influence the local biological response, the available clinical evidence does not establish a relationship between incision characteristics and orthodontic acceleration. Differences in surgical technique are accompanied by differences in patient and treatment characteristics, making direct comparisons between protocols susceptible to confounding. Comparative trials using standardized surgical protocols are therefore required before the influence of incision characteristics can be determined.

Influence of the comparator

The comparator intervention is an important source of clinical heterogeneity. Most included trials compared piezocision with conventional orthodontic treatment, whereas Rao et al. compared piezocision with micro-osteoperforation (MOP), an intervention also intended to accelerate orthodontic tooth movement. Kilinc and Baka included both MOP and conventional orthodontic treatment as comparator groups.[20,21] These comparisons address related but distinct clinical questions. Consequently, results from active-comparator trials should not be interpreted as equivalent to comparisons of piezocision with conventional orthodontic treatment alone. Future studies and meta-analyses should distinguish the comparator type when sufficient evidence becomes available.

Clinical interpretation

The findings suggest that piezocision may accelerate the early mandibular anterior alignment phase of fixed orthodontic treatment. However, this should not be interpreted as evidence of a comparable reduction in total orthodontic treatment duration. The biological rationale for an early effect is plausible because piezocision produces localized cortical injury intended to stimulate a transient regional remodelling response; nevertheless, the clinical benefit appears to be variable across studies. Furthermore, no established minimal clinically important difference for reduction in alignment time was identified, and therefore the clinical importance of the pooled 46-day difference cannot be determined solely from statistical significance.

Overall, the evidence indicates a potential benefit of piezocision for accelerating initial mandibular anterior alignment, but the confidence in the magnitude of this effect is limited by substantial heterogeneity, variation in surgical protocols and comparators, and inconsistent definitions of alignment completion. Future adequately powered randomized controlled trials should use standardized piezocision protocols, clearly defined and clinically justified alignment endpoints, comparable orthodontic mechanics, and validated patient-centred outcomes. Longer follow-up is also required to determine whether acceleration of the initial alignment phase translates into a meaningful reduction in overall orthodontic treatment duration.

Strengths and limitations

The strengths of this review include restriction to randomized controlled trials, independent study selection and data extraction, use of the Cochrane Risk of Bias 2 tool, and quantitative synthesis only when outcome data were considered sufficiently comparable. Nevertheless, the evidence base was limited to six randomized controlled trials, with four studies contributing to the quantitative syntheses. The small number of studies limits statistical precision and does not permit reliable investigation of potential sources of heterogeneity.

Given the small number of studies contributing to the meta-analysis, formal subgroup analyses and meta-regression were not considered appropriate; potential sources of heterogeneity were therefore evaluated narratively.
Several sources of clinical and methodological heterogeneity were identified. The studies varied in initial crowding severity, orthodontic mechanics and archwire progression, patient characteristics, timing and surgical characteristics of piezocision, comparator interventions, follow-up periods, and outcome definitions. In particular, completion of alignment was defined using different LII thresholds ($\leq$1 mm or $\leq$2 mm), limiting direct comparability of alignment-time estimates. The very high heterogeneity observed for alignment time (I^2 = 93%) further reduces confidence in the generalizability of the pooled magnitude of effect. The differing comparator interventions are also relevant, as micro-osteoperforation represents an active acceleration procedure rather than conventional orthodontic treatment alone.

The restriction to English-language publications may have introduced language bias because studies published in other languages were excluded owing to the unavailability of translation resources. The small number of eligible studies also precluded a meaningful assessment of publication bias. In addition, the review protocol was not prospectively registered in PROSPERO. These limitations should be considered when interpreting the apparent benefit of piezocision.

CONCLUSION

Overall, the available evidence suggests that piezocision may accelerate the early alignment of mandibular anterior teeth. This is supported by the statistically significant pooled reduction in alignment time; however, the magnitude of the effect varied considerably between studies, as reflected by the very high heterogeneity. The findings support a possible acceleration effect but do not establish a consistent or predictable clinical advantage across patients or treatment protocols.

Future recommendations

Future randomized controlled trials should adopt standardized piezocision protocols, clearly defined comparator groups, and a clinically justified and consistent definition of alignment completion. Studies should report both times to achieve alignment and total orthodontic treatment duration, together with validated measures of pain and discomfort, periodontal outcomes, adverse effects, patient-reported outcomes, and treatment-related costs. Adequately powered trials with longer follow-up are needed to determine whether acceleration of the initial alignment phase translates into a clinically meaningful reduction in overall orthodontic treatment duration.

ETHICS

Ethics committee approval: Not applicable
Informed consent: Not applicable
Conflict of interest: None
Funding: This study did not receive any funding from public or private sectors.

REFERENCES

1. Pacheco Pereira C, Pereira JR, Dick BD, Perez A, Flores-Mir C. Factors associated with patient and parent satisfaction after orthodontic treatment: a systematic review. Am J Orthod Dentofacial Orthop. 2015 Oct;148(4):652-9.
2. Cho R, Panariello B. Oral Microbial and Biofilm Changes in Response to Clear Aligners: A Scoping Review. Oral Sphere J. Dent. Health Sci. 2026;2(2):132-143.
3. Pilon JJ, Kuijpers-Jagtman AM, Maltha JC. Magnitude of orthodontic forces and rate of bodily tooth movement. An experimental study. Am J Orthod Dentofacial Orthop. 1996 Jul;110(1):16-23.
4. Katara AA, Minhas R, Kumar A, Dasgupta S. A case report on the excision of irritational fibroma using the diode laser. Journal of Dental Research and Review. 2020 Jan;7(1):24-6.
5. Van Leeuwen EJ, Kuijpers-Jagtman AM, Von den Hoff JW, Wagener FA, Maltha JC. Rate of orthodontic tooth movement after changing the force magnitude: an experimental study in beagle dogs. Orthod Craniofac Res. 2010 Nov;13(4):238-45.
6. Lee W. Corticotomy for orthodontic tooth movement. J Korean Assoc Oral Maxillofac Surg. 2018 Dec;44(6):251-258.
7. Goyal A, Kalra JPS, Bhatiya P, Singla S, Batra P. Periodontally accelerated osteogenic orthodontics (PAOO) - a review. J Clin Exp Dent. 2012;4(5):e292-6.
8. Park YG. Corticision: A Flapless Procedure to Accelerate Tooth Movement. Front Oral Biol. 2016;18:109-17.
9. Alikhani M, Raptis M, Zoldan B, Sangsuwon C, Lee YB, Alyami B, Corpodian C, Barrera LM, Alansari S, Khoo E, Teixeira C. Effect of micro-osteoperforations on the rate of tooth movement. Am J Orthod Dentofacial Orthop. 2013 Nov;144(5):639-48.
10. Kachari M, Nandhini K, Sarangi S, Banik A, Chinnasamy BR, Kumar N, Kashwani R. Genetic susceptibility to external root resorption following endodontic, orthodontic and oral surgical interventions: a case-control study. Genetics and Molecular Research. 2026 Jun 25.

11. Aksakalli S, Calik B, Kara B, Ezirganli S. Accelerated tooth movement with piezocision and its periodontal-transversal effects in patients with Class II malocclusion. Angle Orthod. 2016;86(1):59-65.
12. Hatrom AA, Zawawi KH, Al-Ali RM, Sabban HM, Zahid TM, Al-Turki GA, Hassan AH. Effect of piezocision corticotomy on en-masse retraction. Angle Orthod. 2020 Sep 1;90(5):648-654.
13. Hafez HS, Shaarawy SM, Al-Sakiti AA, Mostafa YA. Dental crowding as a caries risk factor: a systematic review. Am J Orthod Dentofacial Orthop. 2012 Oct;142(4):443-50.
14. Genji L, Varghese RM, Subramaniyan AK. Comparison of duration of leveling and aligning in different types of crowding in lower anteriors. J Pharm Negat Results. 2022;13(Spec Issue 8):1255-62.
15. Baldridge DW. Leveling the curve of Spee: its effect on mandibular arch length. JPO J Pract Orthod. 1969 Jan;3(1):26-41.
16. Gravina MA, Brunharo IH, Fraga MR, Artese F, Campos MJ, Vitral RW, Quintão CC. Clinical evaluation of dental alignment and leveling with three different types of orthodontic wires. Dental Press J Orthod. 2013 Nov-Dec;18(6):31-7.
17. Kumar P, Muddaiah S, Reddy GB, Somaiah S, Mathew S. Comparative evaluation of the efficacy of self-ligating brackets with and without piezocision in relieving lower anterior crowding. J Contemp Orthod. 2025;9(4):523-527.
18. Gibreal O, Hajeer MY, Brad B. Efficacy of piezocision-based flapless corticotomy in the orthodontic correction of severely crowded lower anterior teeth: a randomized controlled trial. Eur J Orthod. 2019 Mar 29;41(2):188-195.
19. Gibreal O, Al-Modallal Y, Al-Assaf M. Evaluation of the efficacy of 3D-guided piezosurgery in accelerating mandibular orthodontic teeth alignment: a randomized controlled trial in adults. Dent 3000. 2022;10(1):281.
20. Rao RN, Oommen KE, Nagate RR, Al-Qarni MA, Ahmed AR, Tikare S, Gokhale ST, AlBariqi AA, Elagib MFA, Chaturvedi S. Convalescing Mandibular Anterior Crowding through Piezocision and the Micro-Osteoperforation Surgical Procedure-A Clinical Comparative Study. J Pers Med. 2024 Jan;14(2):173.
21. Kilinc B, Baka ZM. Comparison of the effectiveness of piezocision and microosteoperforation in leveling mandibular anterior teeth. Am J Orthod Dentofacial Orthop. 2023 Apr;163(4):491-500.
22. Uribe F, Davoody L, Mehr R, Jayaratne YSN, Almas K, Sobue T, Allareddy V, Nanda R. Efficiency of piezotome-corticision assisted orthodontics in alleviating mandibular anterior crowding-a randomized clinical trial. Eur J Orthod. 2017 Nov;39(6):595-600.
23. Charavet C, Lecloux G, Jackers N, Albert A, Lambert F. Piezocision-assisted orthodontic treatment using CAD/CAM customized orthodontic appliances: a randomized controlled trial in adults. Eur J Orthod. 2019 Sep;41(5):495-501.