

Five years of evidence: a retrospective analysis of clinical trials comparing electric and manual toothbrush effectiveness in orthodontic patients

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Abstract

Aim: To evaluate whether the use of an electric toothbrush represents a more effective option than a manual toothbrush in preventing dental plaque accumulation and managing daily oral hygiene in patients undergoing fixed orthodontic treatment, considering the increased cleaning challenges associated with the presence of orthodontic appliances. This study provides a comprehensive five-year literature update on the subject.

Materials and methods: A thorough literature search was conducted in PubMed for articles published from January 2020 to June 2025. This retrospective review was designed according to the guidelines of the Cochrane Handbook for Systematic Reviews and is reported in accordance with the PRISMA guidelines. To evaluate the methodological quality of the included randomized controlled trials, the Risk of Bias 2 (RoB 2) tool was employed.

Results: A total of 666 articles were analyzed. Based on the inclusion and exclusion criteria, four studies met the criteria for the final review. According to the RoB 2 assessment, three studies were judged to have 'some concerns' regarding the risk of bias, and only one article was at low risk of bias.

Conclusion: The data from the studies analyzed indicate that, in the short term, the use of an electric toothbrush results in a significant improvement in plaque removal and a reduction in gingival conditions and bleeding on probing compared to a manual toothbrush; conversely, in the long term, the differences between the two types of toothbrush tend to decrease significantly. From this perspective, it becomes essential to consider the electric toothbrush as part of an integrated, personalized approach that includes continuous education, motivational strategies, and consistent follow-up to ensure adequate compliance throughout the entire orthodontic treatment period.

Keywords: biofilm control; gingivitis; orthodontic appliances; manual toothbrush; electronic toothbrush; manual vs electronic toothbrush; fixed orthodontic appliances; periodontal health; fixed appliances; oral hygiene.



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How to Cite

Aurora Pasqualini, Matteo Saccucci, Chiara Fabroni, Beatrice Rossi, Giulia De Durante, Rosa Esposito, Elisabetta Vacros, Iole Vozza.

Five years of evidence: a retrospective analysis of clinical trials comparing electric and manual toothbrush effectiveness in orthodontic patients.

Annali Di Stomatologia, 17(1), 210-219.

<https://doi.org/10.59987/ads/2026.1.210-219>

Introduction

Dear Doctor, is it better to use a manual or an electric toothbrush? This is the question most commonly asked during initial visits by both children and adolescents. (1) This is particularly true when the patient is about to have fixed multi-bracket braces fitted. In fact, it is well known that the application of orthodontic brackets increases the difficulty for pediatric and adolescent patients in reducing bacterial plaque accumulation at the bracket-adhesive interface. (2) (3) (4) (5) (6) In the past, this tendency has been associated with the appearance of demineralization that can threaten the integrity of the tooth and, consequently, its aesthetic appearance. (7) (8) In 2021, Sivaramakrishnan, in an attempt to address this dilemma with scientific evidence, concluded that the electric toothbrush is a promising alternative for reducing plaque accumulation around the bracket. (9) However, the same author points out that long-term follow-up studies were needed to corroborate this statement (10). Elkerbout corroborates this statement by explaining that, as a result of a systematic review, electric toothbrushes are superior to manual toothbrushes in terms of plaque removal, even in patients not undergoing orthodontic treatment, when performing a single toothbrushing exercise. (11) In our study, we aim to review the scientific literature published over the last five years to assess whether, in patients undergoing fixed orthodontic treatment, the use of an electric toothbrush is a more effective option than a traditional toothbrush in preventing dental plaque formation and managing daily oral hygiene, taking into account the greater difficulty in cleaning caused by the presence of orthodontic appliances.

Materials and methods

Study Protocol

This review was conducted in accordance with the guidelines of the Cochrane Handbook for systematic reviews of interventions (12) (13) and the PRISMA guidelines (13).

Eligibility criteria

The methodology is based on the PICO search criteria (Table 1) from studies of patients undergoing orthodontic treatment with fixed therapy using electric or manual toothbrushes. The inclusion criteria adopted were the following: random clinical studies; studies in which the ability to brush the teeth with manual and electric toothbrushes was compared in orthodontic patients.

Table 1. Pico elements.

Population (P)	Patients undergoing orthodontic treatment
Intervention (I)	Electronic toothbrush
Comparison (C)	Manual toothbrush
Outcome (O)	Clinical improvement in periodontal status Changes in periodontal indices

Exclusion criteria were: studies in which subjects with periodontal disease were considered; systematic reviews or meta-analyses; studies in which fixed therapy was performed with ceramic or lingual brackets.

Data extraction

Two independent reviewers (C.F. and A.P.) searched PubMed for literature published in English from January 2020 to June 2025, using the above-mentioned inclusion criteria. The search string was finalized using both FREE TEXT TERMS and MESH terms as below: (((orthodontics[MeSH Terms]) OR (orthodontic*)) AND ((toothbrushing[MeSH Terms]) OR (toothbrushing))) AND (((orthodontics[MeSH Terms]) OR (orthodontic*)) AND ((toothbrushing[MeSH Terms]) OR (toothbrushing))) OR (((((((manual*) OR (conventional*)) OR (hand brush*) OR (power*)) OR (mechanical*)) OR (electric*)) OR (electronic)) OR (ultrasonic*)) OR (sonic*)) OR ("motor driven"))). Filters: articles in English. Duplicate articles were removed. The eligibility of the studies was independently assessed by two authors (C.F., A.P.), who initially reviewed the titles and abstracts of the reviews. The full texts were consulted whenever it was unclear whether the review should be included. In case of disagreement, this was resolved through discussion and consensus with a third author, an expert who was asked to arbitrate (B.R.).

Data collection and data synthesis

The two authors (A.P., C.F.) independently selected the data (authors, year of publication, study design, sample size, sample composition by sex and age, primary and secondary outcomes, evaluation method, sampling intervals, and criteria for inclusion and exclusion) of the selected studies using a predefined extraction form. Any disagreements were resolved through discussion and consensus by a third expert author who was asked to arbitrate (B.R.).

For each study included in this review, the following data were collected:

- The first author, year, journal, and funding
- The characteristics of the population: sample size, age range, and sex ratio
- The intervention group data: electronic toothbrush (type, characteristics, duration, and follow-up)
- Control group data: manual toothbrush (type, characteristics, duration, and follow-up)
- Statistically significant study results
- The study conclusions

Quality Assessment

Two authors (C.F. and A.P.) independently assessed the Risk of Bias of the included studies using the Risk of Bias (ROB2) tool developed by the Cochrane Collaboration. (14). It consists of 5 domains: for each domain, a signaling question is proposed to guide the assessment of methodological quality and to facilitate understanding of how the RoB 2 tool operates and the different sources of potential bias in clinical studies. (Table 2)

Any disagreements were initially resolved through discussion or, if necessary, in collaboration with a third author (G.D.D.).

Table 2. Domain of Risk of Bias (ROB2)

DOMAIN	QUESTION	ANSWER
Risk of bias arising from the randomization process	Was the allocation sequence random? Were all participants identified before randomization?	Y/PY/PN/N/NI/NA
Risk of bias due to deviations from the intended interventions	Were participants and personnel aware of the assigned intervention? Could this awareness have led to significant deviations from the intended intervention?"	Y/PY/PN/N/NI/NA
Risk of bias due to missing outcome data	Are the missing outcome data sufficiently extensive to have a notable impact? Is the missingness likely to depend on the true value of the outcome, potentially affecting the results?	Y/PY/PN/N/NI/NA
Risk of bias in the measurement of the outcome	Were outcome assessors blinded to the intervention assignment? Were the methods of outcome measurement appropriate for the outcome in question?	Y/PY/PN/N/NI/NA
Risk of bias in the selection of the reported result	Were the reported results analyzed in accordance with a pre-specified analysis plan?	Y/PY/PN/N/NI/NA

Results

Selected studies

An electronic search on PubMed yielded 666 results from January 2020 to June 2025. Of these, 640 titles were discarded as clearly not relevant, while 26 abstracts were screened. In total, four studies were included in this review of systematic reviews. A PRISMA flowchart for the study selection process is presented in Figure 1. A qualitative summary of the studies included is presented in Table 3.

Narrative synthesis of the studies

The first article analyzed, authored by Erden et al. (15), is a randomized clinical trial conducted at a single center and examiner-blinded. The primary objective was to determine which type of toothbrush proved more effective in dental plaque control, reduction of gingival inflammation and bleeding on probing, as well as to assess changes in salivary levels of cariogenic bacteria such as *Streptococcus mutans*, *Lactobacillus casei*, and *Porphyromonas gingivalis*. The study involved 40 orthodontic patients aged between 12 and 18 years, all right-handed, fitted with Roth 0.018-inch brackets and metallic ligatures, and who performed manual toothbrushing daily. Inclusion criteria also required the absence of physical or mental disorders and a mean plaque index score of at least 1.75. Exclusion criteria comprised the presence of systemic diseases, regular drug use, tooth rotations or diastemas, additional orthodontic components, poor compliance, smoking, labial surface restorations, and the use of antibiotics or antibacterial agents within the previous three months. Participants were randomly assigned to two groups, each following a distinct oral hygiene protocol: one group used a manual toothbrush (Oral-B Ortho Brush with soft bristles).

In contrast, the other used an electric toothbrush (Oral-B

Genius 8900) equipped with a pressure sensor and a two-minute timer. The latter device employs a so-called three-dimensional cleaning technology that combines oscillating, rotating, and pulsating movements to enhance cleaning efficacy. Both groups used the same toothpaste containing 1450 ppm fluoride and were instructed in the modified Bass brushing technique, supported by a demonstrative video. Participants were also instructed not to use any additional oral hygiene aids. Clinical assessments were performed at baseline (T0), after six weeks (T1), and after twelve weeks of follow-up (T2). The results demonstrated greater efficacy of the electric toothbrush in reducing the plaque index (PI), with significantly lower values than those of the manual toothbrush at the subsequent evaluation time points. However, both groups showed a progressive decrease in plaque index scores between baseline and 12 weeks.

Regarding the gingival index (GI) and bleeding on probing (BOP), no statistically significant differences were observed between the two groups, although both exhibited improvement over time. Regarding bacterial parameters, *Streptococcus mutans* levels were higher in the electric toothbrush group, although these differences were not statistically significant throughout the study period. *Porphyromonas gingivalis* levels showed non-significant variations, while *Lactobacillus casei* exhibited no differences between the groups at any of the evaluation points. In summary, the study highlights that an interactive electric toothbrush may be an effective tool for improving plaque control in patients undergoing orthodontic treatment, with potential positive effects on patient motivation and compliance. Despite the observed clinical efficacy in plaque management, the impact of the electric toothbrush on cariogenic bacterial levels warrants further investigation to achieve a more comprehensive understanding.

Bilen et al. (16) designed a parallel-group randomized

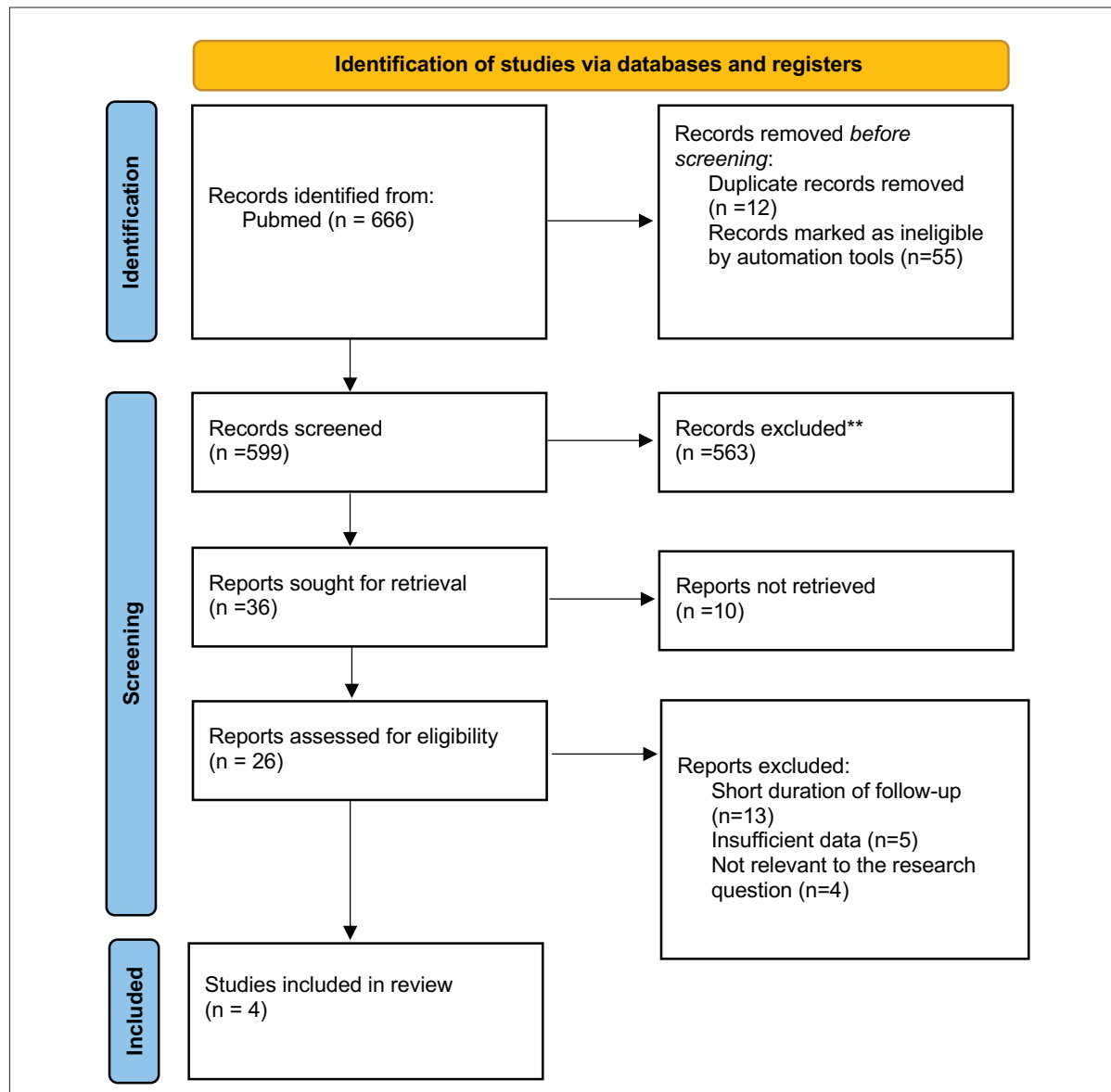


Figure 1. PRISMA 2020 flow diagram for new systematic reviews, which included searches of databases, registers, and other sources

clinical trial to investigate the short-term effects of manual and electric toothbrush use on patients' periodontal status undergoing fixed orthodontic treatment. A total of 36 patients aged 12-18 years, all presenting with permanent dentition and indications for non-extraction orthodontic therapy, were selected for the study. Inclusion criteria comprised right-handed patients with no prior experience using an electric toothbrush and homogeneity in bracket type and ligation technique. Exclusion criteria included the absence of missing teeth, the presence of systemic or periodontal diseases, physical impairments that could affect toothbrushing, and the use of narcotic substances within the previous two months. Participants were randomly allocated into two distinct groups: one group used a manual toothbrush with an orthodontic head and employed the modified Bass brushing technique, supported by an instructional video; the other group

used an electric toothbrush (Oral-B Interactive 8900) in conjunction with a smartphone application provided by the manufacturer, containing usage instructions. Both groups brushed twice daily for two minutes using the same toothpaste. The manual toothbrush group used an external timer, whereas the electric toothbrush group used the device's built-in timer. Throughout the study period, the use of additional oral hygiene aids was prohibited. The follow-up period lasted four months, with assessments conducted at baseline (T0), after 4 weeks (T1), 2 months (T2), and 4 months (T3). The clinical parameters monitored included the modified Silness and Løe plaque index (PI), the gingival index (GI), and bleeding on probing (BOP), with particular attention to gingival inflammation observed within 30 seconds of bleeding. The results demonstrated a significant reduction in plaque index in the electric toothbrush group at all evaluation time points.

Table 3. Qualitative synthesis of the studies

	Erden T et al. 2024 (15)	Bilen et al. 2021 (16)	Johal et al. 2023 (17)	Mylonopoulou et al. 2021 (18)
Oral regiment at baseline	Brush daily	Not specified	Brush at least twice a day	Not specified
Oral regiment during treatment	Not specified	Brush twice a day for 2 minutes	Brush twice a day for 2 minutes	Brush twice a day for 2 minutes
Oral prophylaxis during treatment	No	No	No	No
Toothbrushing technique during treatment	Modified Bass technique	Modified Bass technique	Not specified	Not specified
Use of auxiliary devices	No	No	Orthodontic interdental brush	No
Brushing force	Pressure sensor	Pressure sensor	Not specified	Pressure sensor
Follow-up	6-12 weeks	1-2-4 months	1-6-12 months	1-2-3 months
Outcome	PI, GI, BOP, Streptococcus m., Lactobacillus c., Porphyromonas g.	PI, GI and BOP	PI, GI and BOP	PI and GI
Results	Only the PI showed a greater decrease in the PT group compared to the MT group	PI, GI, and BOP decreased significantly in the PT group	The effects of the type of toothbrush are insignificant based on PI, GI, and BOP	The effects of the type of toothbrush were insignificant based on PI and GI

In contrast, the manual toothbrush group exhibited smaller changes, particularly between two (T2) and four months (T3). Changes in the gingival index followed a pattern similar to that of bleeding on probing in the electric toothbrush group, with significant improvements throughout the observation period. Both groups showed significant reductions in BOP from baseline to the subsequent evaluations at two and four months; however, the electric toothbrush group also demonstrated a significant improvement between one and four weeks. No statistically significant differences between the groups were observed regarding bleeding on probing. In conclusion, the study by Bilen et al. indicates that the use of an electric toothbrush results in statistically significant improvements in the plaque and gingival indices compared to a manual toothbrush in orthodontic patients over the short term. These findings support the efficacy of electric toothbrushes in enhancing periodontal health in this vulnerable population, highlighting the importance of appropriate oral hygiene tools for patients undergoing fixed orthodontic treatment.

In contrast, the study by Johal et al. (17) was a randomized, controlled, parallel-group clinical trial comparing the long-term efficacy of manual and electric toothbrushing in adolescent patients undergoing fixed orthodontic treatment. A total of 92 patients aged 12-18 years, in good general health and non-smokers, were included in the study. Exclusion criteria ruled out individuals with prior experience using electric

toothbrushes, patients with special needs or learning difficulties, a history of periodontitis or attachment loss, those who had undergone oral prophylaxis within the previous four weeks, or those who had used antibacterial mouthwashes or antibiotics in the past month. Patients with five or more active carious lesions requiring immediate treatment were also excluded. Participants were randomly assigned to two groups: one group used a manual toothbrush (Oral-B Indicator Medium 35), and the other used a sonic electric toothbrush (ProClinical A1500). The sonic toothbrush generates high-frequency vibrations, typically exceeding 30,000 oscillations per minute, producing a fluid-dynamic effect within the oral cavity. This action is not limited to the mechanical cleaning achieved by direct bristle contact with the tooth surface; it also creates turbulence within the fluid mixture of saliva and toothpaste. This phenomenon enhances the removal of bacterial plaque in interdental areas and along the gingival margins, regions that are otherwise difficult to reach with conventional mechanical action. All participants were provided with toothpaste containing 1450 ppm fluoride and were instructed to maintain adequate oral hygiene by brushing twice daily for at least two minutes.

The use of interdental brushes was also encouraged to improve cleaning around the fixed appliances. The electric toothbrush group received additional instructional support regarding device maintenance, including charging and periodic replacement of brush heads, reinforced by a demonstrative video. The

study follow-up lasted 12 months, with assessments conducted at baseline (T0), 1 month (T1), 6 months (T2), and 12 months (T3). The clinical parameters evaluated included the plaque index (PI), the gingival index (GI), and bleeding on probing (BOP). Final results revealed no statistically significant differences between the two groups in plaque index, gingival index, or bleeding on probing at any evaluation time point. However, deterioration in plaque control and periodontal parameters was observed over the follow-up, likely due to the intrinsic complexity of maintaining proper oral hygiene with fixed orthodontic appliances. In conclusion, the study by Johal et al. demonstrates that, both in the short and long term, there are no significant differences in plaque control and gingival health between manual and electric toothbrushes in adolescent patients with fixed orthodontic appliances. This finding highlights that neither brushing method alone is sufficient to ensure adequate oral hygiene in this population, underscoring the importance of ongoing clinical support and personalized motivational strategies throughout orthodontic treatment.

The study conducted by Mylonopoulou et al. (18) was a single-blind, parallel-group randomized clinical trial designed to compare the effectiveness of three-dimensional electric toothbrushes with manual toothbrushes in maintaining oral health in patients with fixed orthodontic appliances. A total of 80 patients aged 12-16 years, in good general health, undergoing non-extraction fixed orthodontic treatment with uniform metal components on both arches, were included in the study. Moderate plaque-induced gingivitis was a prerequisite for inclusion. Exclusion criteria included active caries, periodontitis, agenesis, syndromic conditions or craniofacial defects, current use of electric toothbrushes, more than two cervical or proximal restorations, prostheses or dental implants, disabilities affecting toothbrushing, peri- or intraoral piercings, need for antibiotic prophylaxis, smoking or tobacco use, and antibiotic intake within the previous two months. Participants were randomly assigned to two groups: one group received a manual toothbrush (Oral-B orthodontic brush), while the other received a three-dimensional electric toothbrush (Oral-B Pro-1000). All participants received standardized instruction on brushing technique, with the recommendation to brush twice daily for two minutes. During the three-month follow-up, with assessments at baseline (T0), one month (T1), two months (T2), and three months (T3), participants were instructed to use the provided toothbrushes and toothpaste exclusively and to report any dental visits during the study period. The outcomes assessed included the Modified Silness and Løe Plaque Index, the Modified Full Mouth Plaque Score, and the Modified Gingival Index. The results demonstrated significant individual variability in outcomes, with no statistically significant differences between the three-dimensional electric toothbrush group and the manual toothbrush group in plaque reduction or gingival inflammation at any evaluation time point. In conclusion, the study by Mylonopoulou et al. demonstrates that, over a short-term period of three months, there are no substantial differences in efficacy between

three-dimensional electric toothbrushes and manual toothbrushes for plaque control and management of gingival inflammation in adolescent patients with fixed orthodontic appliances. These findings highlight the need for further research to clarify potential long-term clinical benefits.

Quality of the Included Studies

The randomized clinical trial by Erden et al. (15) provides a detailed and controlled description of the randomization process, significantly reducing the likelihood of bias. Although there were no relevant deviations from the planned intervention, some concerns were noted due to the single examiner's blinding. The 12-week follow-up was complete and adequately structured, with no reports of unaddressed dropouts or losses, thereby minimizing the risk associated with incomplete outcome data. Outcome assessment appears reliable, owing to examiner blinding, which limits potential influences on the measurement of plaque, gingival, and microbiological indices. Reporting was consistent and comprehensive with respect to the pre-specified outcomes, with no evidence of selective reporting or omission of results that could compromise overall transparency; however, the selection protocol was not preregistered. Overall, the study demonstrates a solid experimental design, although the lack of participant blinding and preregistration raises some concerns.

The randomization process in Bilen et al.'s study. (16) is clearly and appropriately described, with procedures that minimize the risk of errors in allocating participants to experimental groups. However, as the randomization process was simple, some concerns arose regarding the adequacy of the method employed. Interventions were conducted in accordance with the pre-established protocol, with only minor deviations from the planned intervention and with equivalent conditions maintained between the comparison groups. This reduces the risk of bias related to deviations from the intended intervention. Some losses to follow-up were reported; however, single-examiner blinding introduces slight uncertainty regarding the risk associated with deviations from the intervention, representing a moderate concern in this domain. Outcome measurement was conducted by blinded evaluators using standardized and validated tools and methods, ensuring high reliability and limiting subjective influence on the assessments. Finally, reporting of the results was complete and consistent with the predefined protocol, with no evidence of selective reporting or omission of outcomes, thereby ensuring transparency and accuracy in data communication. Nevertheless, retrospective registration raises some concerns. In summary, the study demonstrates a moderate overall risk of bias, with slight uncertainty limited to the randomization process and the selection of reported results, which should be considered in the critical interpretation of the findings.

The randomization procedure in the study by Johal et al. (17) was clearly described and rigorously implemented, ensuring a correct and random allocation of participants to the different experimental groups and minimizing the risk of assignment-related bias. No significant deviations

from the planned interventions were observed, ensuring that all participants followed homogeneous treatment protocols and that study conditions remained consistent across groups. Single-examiner blinding raises some concerns. The follow-up was complete and thoroughly documented, substantially reducing the possibility of bias arising from missing data or unaddressed losses in outcome assessment. Outcomes were measured by blinded evaluators using validated and standardized tools, ensuring impartiality and reliability in clinical and microbiological measurements. Reporting of results was consistent with the prescribed protocol, with no evidence of omissions or selective presentation, confirming the transparency and completeness of the research. In conclusion, the study demonstrates a low overall risk of bias, providing robust and reliable data for clinical evaluation, with high methodological quality across the design, execution, and reporting phases. The randomization process in the study by Mylonopoulou et al. (18) was described in detail and rigorously implemented, ensuring a correct random allocation of participants to the two experimental groups and minimizing the risk of allocation-related bias. No significant deviations from the planned interventions were observed, ensuring that participants adhered faithfully to the assigned brushing protocols and that intervention conditions remained consistent. However, single-examiner blinding introduces a moderate risk of bias in this domain. The follow-up was complete and carefully documented, with regular assessments minimizing the impact of any losses or missing data on the evaluation of clinical outcomes. Nonetheless, single-examiner blinding introduces a moderate risk in this domain. Outcome measurements were conducted by blinded evaluators using validated methodologies and standardized instruments, ensuring objectivity and reliability in clinical assessments. Finally, reporting of results was transparent and consistent with the original study protocol, with no omissions or selective data presentation that could compromise research integrity. Some concerns arise from the lack of preregistration of the protocol. Overall, the study demonstrates a moderate risk of bias, providing solid and reliable data for clinical interpretation and confirming a high level of methodological rigor across the different phases of the research.

Discussion

The four randomized clinical trials analyzed by (15), (16), (17), and (18) converge on a common interest: the comparative evaluation of the effectiveness of manual toothbrushes versus electric toothbrushes in the oral hygiene of adolescent orthodontic patients. This issue is particularly important given the greater difficulty of maintaining adequate oral hygiene with fixed appliances. Despite the homogeneity of the topic, methodological and outcome differences emerge that deserve careful consideration.

The studies by Erden et al. (15) and Bilen et al. (16), with follow-ups of 12 weeks and 4 months, respectively, reports a significant advantage of electric toothbrushes in controlling the plaque index (PI). The improvement, already evident from the first measurements after baseline (T1 and T2), remains constant and more pronounced in the group treated with electric toothbrushes, demonstrating superior mechanical effectiveness and greater ease of use. This result can be attributed to the oscillatory, rotary, and vibratory movements characteristic of electric toothbrushes, which make plaque removal less dependent on individual manual skill than with traditional toothbrushes. This result can be attributed to the oscillatory, rotary, and vibrational movements characteristic of electric toothbrushes, which make plaque removal less dependent on individual manual skill than with traditional toothbrushes.

In contrast, the study by Johal et al. (17), conducted with a 12-month follow-up, found no statistically significant differences between the two groups. On the contrary, progressive worsening of plaque control was observed over time, highlighting that the duration of orthodontic treatment itself is a significant obstacle to maintaining effective hygiene, regardless of the type of device used. This trend seems to reflect the influence of additional factors, including decreased motivation, technical difficulties with brushing, and the absence of regular clinical support, which negatively affect compliance and, consequently, the overall effectiveness of oral hygiene maneuvers. Instead, the study by Mylonopoulou et al. (18), with a 3-month follow-up, documents high individual variability in results and finds no

Table 4. Risk of bias assessment based on the ROB2.

Rob2- Domains	Erden et al. 2024 (15)	Bilen et al. 2021 (16)	Johal et al. 2023 (17)	Mylonopoulou et al. 2021 (18)
Randomization	Low risk	Some concerns	Low risk	Low risk
Deviations from intended intervention	Some concerns	Some concerns	Some concerns	Some concerns
Incomplete outcome data	Low risk	Low risk	Low risk	Low risk
Outcome measurement	Low risk	Low risk	Low risk	Low risk
Selection of the reported results	Some concerns	Some concerns	Low risk	Some concerns
Overall judgement	Some concerns	Some concerns	Low risk	Some concerns

statistically significant differences compared to manual toothbrushes. This evidence suggests that, even with advanced technologies, treatment response can vary substantially across individual patients, highlighting the importance of personalized strategies in clinical follow-up. However, when analyzing follow-up periods, it is essential to account for methodological factors such as the Hawthorne effect (19), a phenomenon in which participants enrolled in a clinical trial alter their behavior simply because they are aware of being observed, thereby influencing their daily activities. In this regard, Robertson et al. (19) emphasize the importance of including a stabilization period between the baseline visit and the actual start of the study to minimize this effect and enhance the reliability of the findings.

In addition to plaque control, gingival indices (GI and BOP) should also be considered, as they provide a relevant measure of inflammation and tissue response to hygiene procedures. Studies by Erden et al. (15) and Bilen et al. (16) report modest, though not always statistically significant, improvements in the differences between manual and electric toothbrushes. However, both groups show progressive reductions in GI and BOP over time. In particular, the study by Bilen et al. (16) showed a significant reduction in bleeding on probing (BOP) in the group using electric toothbrushes, with significant improvements observed between baseline (T0) and 2 months (T2) and between baseline and 4 months (T3). As for the gingival index (GI), there was a significant decrease at 4 weeks (T3) in the manual toothbrush group, although significant reductions in GI were also observed between T0 and T2, T0 and T3, and between T1 and T3 in both groups.

On the other hand, a significant improvement in BOP was noted between baseline and 12 weeks, whereas differences in the gingival index between T0, T1, and T2 were not significant (15); however, both groups showed an improvement in GI between baseline and 3 months (T0-T2). These data indicate a clinical benefit in both reducing gingival bleeding, which was more pronounced with the electric toothbrush, and improving the gingival index, with evidence favoring a more rapid reduction in bleeding in patients using the electric toothbrush. In contrast, Johal et al. (17) found no differences between the two groups. They reported a worsening of gingival condition in the entire sample over the long term, between T0 and T3 (0-12 months), indicating that the complexity of maintaining hygiene in the advanced stages of orthodontic treatment may compromise the initial benefits, as shown in the study by Mylonopoulou et al. (18), on the other hand, confirms the absence of significant advantages in gingival control with three-dimensional toothbrushes compared to manual ones, perhaps due to variability in individual responses and the multiple factors that influence gingival status beyond the brushing tool alone.

It should also be highlighted that the studies conducted by Bilen, Johal, and Mylonopoulou clearly define the instructions for toothbrushing, including the recommended duration and frequency per day (2'-2 times/day), in accordance with the ideal technique also outlined by Attin et al.

Another important aspect is the type of toothbrush

used. In the studies conducted by Erden T. et al. (15) and Bilen et al. (16), two models of electric toothbrushes from the same series are used: The Oral-B Genius 8900 (15) and the Oral-B Interactive 8900. (16) Both of these toothbrushes use three-dimensional movement technology that combines oscillating, rotating, and pulsating movements, featuring built-in pressure sensors and a timer to control brushing time. The results of these two studies (15) (16) converge in demonstrating an effective reduction in plaque index and improvements in gum health indicators compared to manual toothbrushes, with additional support for adhering to oral hygiene protocols provided by the associated digital features, as reported by Mylonopoulou et al. (18), a three-dimensional electric toothbrush (Oral-B Pro-1000), was used, with less pronounced results during the short observation period (3 months), during which no significant differences were found compared to manual toothbrushes in plaque control and the management of gingival inflammation. In contrast to these, the study by Johal et al. (17) stands out for its use of a sonic electric toothbrush (ProClinical A1500), which uses high-frequency vibrations to induce fluid dynamics in the oral cavity. In addition to mechanical cleaning, this type of toothbrush exploits turbulence in the saliva-toothpaste mixture, facilitating the removal of plaque even in areas that are difficult to reach with mechanical action alone. However, the results of this study (17) show no statistically significant differences in plaque control or long-term gum health between sonic and manual toothbrushes, suggesting the inherent complexity of maintaining effective oral hygiene during fixed orthodontic treatment. The study by Erden et al. provides a distinctive insight. (15), which integrates microbiological analysis of salivary levels of cariogenic bacteria such as *Streptococcus mutans*, *Lactobacillus casei*, and *Porphyromonas gingivalis* with assessments of periodontal condition. Although the electric toothbrush showed greater effectiveness in reducing plaque, no significant differences in the reduction of the above-mentioned bacteria were observed between the groups during the 12-week observation period. This suggests that simple mechanical cleaning, while essential, may not be sufficient to substantially alter the composition of the oral bacterial flora in a short period of time, emphasizing the need for further investigation to understand how different brushing methods affect oral ecology and, therefore, the risk of caries and periodontal disease in orthodontic patients. Differences in follow-up durations are crucial for the correct interpretation of results. Short-term studies (12 weeks – 4 months) (15) (16) (18) show an advantage for electric toothbrushes, while long-term observations (12 months) (17) show a progressive reduction in this benefit, highlighting the inherent difficulties in maintaining adequate oral hygiene during prolonged orthodontic treatment. It follows that, in addition to the mere choice of tool, educational and motivational factors, as well as constant clinical monitoring, play a decisive role. Clinical recommendations should therefore not be limited to simply recommending the use of electric toothbrushes, but should also include ongoing support programs, periodic follow-ups, and patient-specific

training. This picture suggests that technology alone is not enough: only a multidisciplinary approach that combines effective cleaning tools, ongoing education, motivation, and clinical monitoring can maintain adequate oral health throughout orthodontic treatment. The observed individual variability also suggests the need for personalized strategies, as not all patients respond the same way to different oral hygiene methods.

Conclusion

- Data from the studies analyzed indicate that, in the short term, the use of an electric toothbrush leads to a significant improvement in plaque removal and a reduction in gum disease and bleeding on probing compared to a manual toothbrush, as measured by recognized clinical indices such as the Silness and Løe index and the gingival index. These results support the adoption of electric toothbrushes as the preferred tool for oral hygiene in orthodontic patients.
- In the long term, the differences between the two types of toothbrush tend to decrease significantly, indicating that maintaining effective oral hygiene over time depends not only on the device used, but also on multifactorial factors such as personal motivation, educational support, and regular clinical check-ups.

With this in mind, it seems essential to consider the electric toothbrush as part of an integrated, personalized approach that includes continuous training, motivational strategies, and ongoing follow-up to ensure adequate compliance throughout the entire orthodontic treatment. Ultimately, while recognizing that electric toothbrushes offer an initial advantage in plaque management and gum health, it is essential to emphasize that the choice of tool should be guided by the patient's individual needs and integrated into a comprehensive oral hygiene plan that effectively supports oral health over time.

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