

The microbiological-clinical turnover during orthodontic treatment

Aurora Pasqualini¹
Chiara Fabroni²
Matteo Saccucci³
Elisabetta Vacros⁴
Lorenza Putignani⁵
Gabriele Di Carlo⁶

¹ Department of Oral and Maxillo-Facial Sciences, Sapienza University of Rome, Italy;

² Private practice, Rome, Italy;

³ Department of Oral and Maxillo-Facial Sciences, Sapienza University of Rome, Italy;

⁴ Private practice, Rome, Italy

⁵ Department of Life Science, Health, and Health Professions, Link University, Rome, Italy;

⁶ Department of Oral and Maxillo-Facial Sciences, Sapienza University of Rome, Italy;

Corresponding author: Matteo Saccucci
e-mail: matteo.saccucci@uniroma1.it

Abstract

Aim: This umbrella review aims to identify the level of evidence regarding the microbiological changes occurring in the oral cavity, with particular attention to changes in the oral microbiota and periodontal indices, in subjects undergoing orthodontic therapy. **Methods:** The methodology is based on the PICO search criteria within a systematic review and meta-analysis performed on patients undergoing orthodontic treatment with fixed multibracket therapy or aligners. The eligibility of the studies selected was independently assessed. The included reviews were assessed using the Assessing the Methodological Quality of Systematic Reviews (AMSTAR 2) tool, which consists of 16 items. **Results:** An electronic search database yielded a total of 457 results from 2000 onwards. Of these, 450 titles were discarded as clearly not relevant, while 7 abstracts were selected for further screening. One included review was classified as grey literature. In total, 8 studies were included in this review of systematic reviews. **Conclusion:** This review of systematic reviews suggests that, although clear aligners may promote better oral hygiene and a temporary decrease in periodontal inflammation compared to fixed appliances, the differences are not clinically significant in the long term. Periodontal indices indicate a slight improvement in CAT compared to FAT. However, these advantages tend to diminish as the treatment progresses. Regarding the oral microbiota, both treatments may cause transient changes; however, no significant modifications are observed that could decisively influence overall periodontal health.

Keywords: biofilm control; gingivitis; orthodontic appliances; clear aligners; removable orthodontic appliances; fixed orthodontic appliances; periodontal health; fixed appliances; oral hygiene.

Introduction

In defining the orthodontic treatment strategy after an accurate diagnosis, which cannot be made without a clear definition of the patient's problem list, the choice of orthodontic technique is of fundamental importance to perform "goal-oriented" orthodontics. The use of a predefined orthodontic technique should follow criteria of efficiency and effectiveness that allow the patient to obtain an orthodontic therapy at the gold standard level with maximum respect for the supporting tissues of the teeth. Nowadays, in



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orthodontics, market competition between orthodontic techniques has led to the rise of aligner therapy (CAT) over traditional multibracket orthodontic techniques (FAT). The use of CAT therapy is undoubtedly linked to the increased demand and willingness of patients to receive aesthetic and comfortable treatment. In addition to this need on the part of patients, there is considerable pressure from the market and from dealers to highlight the alleged biological advantages of aligners, which make this technique superior to FAT treatment in the eyes of the orthodontist. A biological advantage of aligners over brackets is often suggested in terms of maintaining oral hygiene and reducing the risk of developing periodontal disease. Moreover, within the literature, it emerges that all orthodontic appliances, whether CAT or FAT, influence the environment of the oral cavity, as the insertion of a foreign surface in the oral cavity causes a reduction in the self-detection capacity of the dental elements and is characterized as a carrier or storage site for bacteria (1) (2) (3)

This has led to the production of several studies, employing both clinical and microbiological approaches, to investigate the changes that occur in the oral cavity during orthodontic treatment. At the same time, these studies have been catalogued by systematic reviews and meta-analyses (4) The body of literature appears to suggest an absolute advantage of one technique over the other, both from the perspective of clinical periodontal indices and oral microbiota.

This review aims to identify the level of evidence regarding the microbiological changes that occur in the oral cavity, with particular attention to changes in the oral microbiota and periodontal indices, in patients undergoing orthodontic therapy with clear aligners compared to those treated with multibracket systems.

Materials and Methods

Study Protocol

This systematic review was conducted by the guidelines of the Cochrane Handbook for **Systematic Reviews of Interventions (Higgins et al., 2011)** and the **PRISMA** guidelines.

Eligibility criteria

The methodology is based on the PICO search criteria (Table 1) in studies conducted on patients undergoing orthodontic treatment with either fixed therapy or aligners. The inclusion criteria adopted were as follows: systematic reviews of prospective and cross-sectional cohort studies, systematic reviews performed on patients undergoing orthodontic treatment, and systematic reviews conducted on patients in fixed or removable therapy with aligners.

Exclusion criteria included all systematic reviews on animal subjects, as well as systematic reviews or meta-analyses in which subjects with periodontal disease were considered, those without a clear description of the materials and techniques applied, and systematic reviews that included studies where the fixed therapy was performed with ceramic brackets or lingual brackets.

Table 1. Pico elements.

Population (P)	Patients undergoing orthodontic treatment
Intervention (I)	Fixed orthodontic therapy
Comparison (C)	Orthodontic therapy with aligners
Outcome (O)	Control of oral bacterial flora Changes in periodontal indices

Data extraction

Two independent reviewers (C.F. and A.P.) conducted a search of electronic databases, including the Cochrane Library, Scopus, and PubMed, among the literature published in English up to September 2024, without date restrictions, according to the above-mentioned inclusion criteria. The search string was finalized using both FREE TEXT TERMS and MESH terms as below: (fixed appliance OR invisalign OR orthodontic aligners OR orthodontic treatment OR fixed orthodontic OR clear aligner OR removable aligner OR orthodontics (MeSH Terms)) OR microbiome (MeSH Terms) OR index, oral hygiene (MeSH Terms) OR oral hygiene (MeSH Terms)) Filters: Systematic Review in English. Some articles were selected through the grey literature analysis, while 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 not clear whether the review should be included or not. In cases of disagreement, this was resolved through discussion and consensus with a third author expert who was asked to arbitrate (L.P.).

Data collection and data synthesis

The two authors (CF, AP) 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 criteria) of the selected studies using a predefined extraction form. Any disagreements were resolved through discussion and consensus with the assistance of a third expert author, who was asked to arbitrate (G.D.C).

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

- The first author, year, journal, and funding
- The design and number of studies included in the qualitative summaries of each review
- The number of studies included in the quantitative meta-analysis
- The characteristics of the population: sample size, age range, and sex ratio
- The intervention group data: treatment performed (type, characteristics, duration, and follow-up of orthodontic treatment with clear aligner)
- Control group data: orthodontic treatment performed (type, characteristics, duration, and follow-up of orthodontic treatment with clear aligner, duration, and follow-up of orthodontic treatment with fixed braces)

- Statistically significant study results
- The study conclusions

Quality Assessment

Two authors (C.F. and A.P.) independently assessed the included reviews using the Assessing the Methodological Quality of Systematic Reviews (AMSTAR 2) tool, which consists of 16 items (12). Any disagreements were initially resolved through discussion or, if necessary, in collaboration with a third author (M.S.).

Results

Selected studies

An electronic search on PubMed, Scopus, and the Cochrane Database of Systematic Reviews yielded a total of 457 results from 2000 onwards. Of these, 450 titles were discarded as clearly not relevant, while 6 abstracts were selected for further screening. One included review was classified as grey literature. In total, eight studies were included in this review of systematic reviews: Jiang et al (2018), Oikonomou et al (2021), Campobasso et al (2021), Llera-Romero et al (2023), Raghavan et al (2023), Crego-Ruiz et al (2023), Pamplona et al (2024), and Lucchese et al (2025). A PRISMA flowchart for the study selection process is presented in Figure 1. A qualitative summary of the reviews included is presented in Table 2.

Narrative synthesis of the studies

In 2021, Jiang et al (2) performed a systematic review to compare periodontal health in patients undergoing orthodontic treatment with clear aligners versus those

undergoing orthodontic treatment with fixed appliances. Ten studies were candidates for quantitative analysis; however, only nine were selected for the meta-analysis, as per the following inclusion criteria: human randomized controlled trials (RCTs) and human cohort studies conducted under healthy conditions.

His studies, selection of the follow-up presented a large variety, ranging from 1.0 to 31.6 months. Clear aligners showed better results in terms of Plaque Index, Gingival index, and probing depth (PD). A meta-analysis showed false positive results with respect to PD due to an insufficient sample size to obtain confirmatory results. Moreover, the level of evidence due to a was downgraded by the authors n elevated risk of bias detected and inconsistency among results its.

Three years later, Oikonomou et al (6) performed a systematic review to identify differences in oral hygiene parameters in patients undergoing orthodontic aligner therapy and fixed therapy. Twenty-one studies were selected, and four were candidates for a meta-analysis, according to the following inclusion criteria: random clinical trials, prospective clinical trials, and observational studies in patients undergoing both CAT and FAT therapy. The results of this review indicate that aligner orthodontic therapy is associated with improved oral hygiene levels in the short term. From a clinical point of view, in subjects wearing aligners, the plaque scores were lower than those treated with fixed appliances within the first two months of treatment; however, no difference was detected for inflammatory indices. The studies selected by Oikonomou are not corroborated by a high level of evidence quality according to GRADE. Instead, the aim of the systematic review by Campobasso et al. was to assess taxonomic microbial changes in

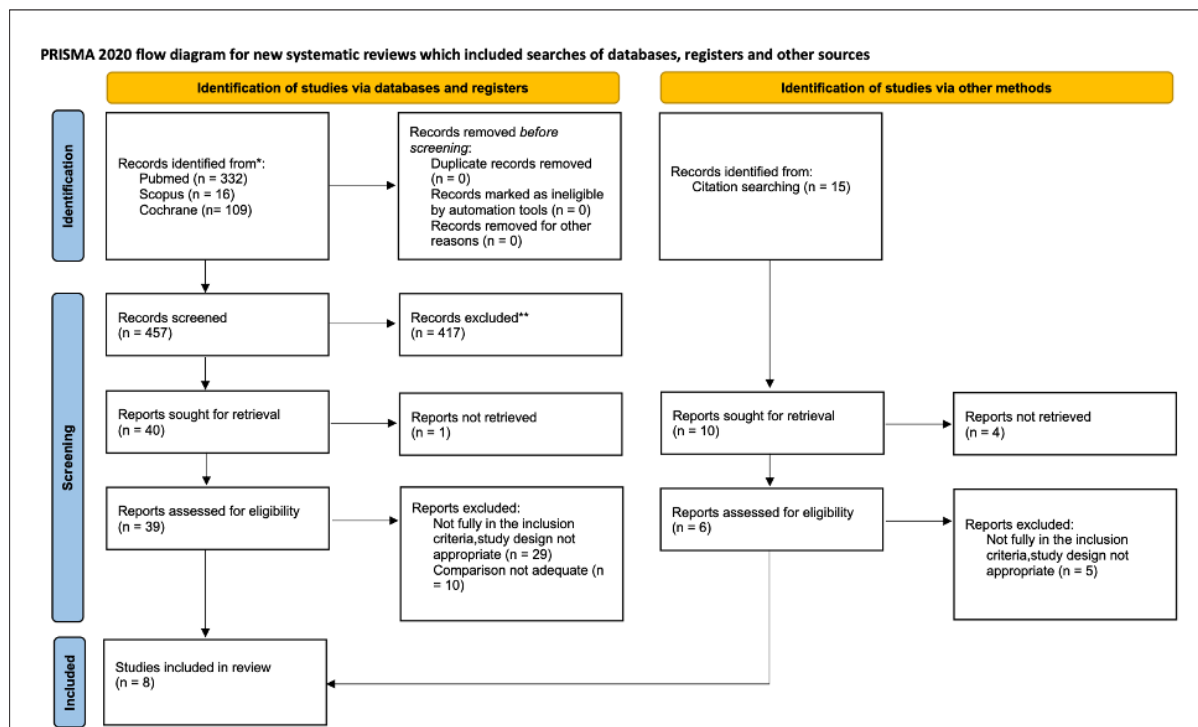


Figure 1. PRISMA 2020 flow diagram for new systematic reviews, which included searches of databases, registers, and other sources

Table 2. Synthesis of the studies

Author	Year	Metanalysis	Design	Population	Conclusion
Jiang et al (2)	2018	Yes	3 RCT 7 Cohort study	494	Clear aligners were better for periodontal health than were fixed appliances, but the quality of the evidence was medium.
Campobasso et al (1)	2021	No	1RCT 5 nRCT	222	Supragingival: FAT causes transient changes in microbial biodiversity that return to basal levels after treatment; CAT does not cause significant changes in microbial composition. Subgingival: both induce transient changes, but CAT does not appear to cause pathogenic changes in the microbiome. Saliva: not significantly affected by either treatment in the long term
Oikonomu et al (6)	2021	Yes	7 RCT 14 nRCT	1156	Aligner orthodontic therapy is associated with better oral hygiene levels in the short term
Llera-Romero et al (7)	2023	Yes	6RCT 3nRCT 14prosp 4 cross 4 retrosp	-	The periodontal indicators analyzed show better values in patients treated with Cas; the plaque and the bleeding index show a significant tendency to improve throughout treatment with CAs. CA patients have a lower biofilm mass no differences were found in the percentage of patients with high <i>S. mutans</i> and <i>Lactobacillus</i> counts.
Crego-Ruiz et al (8)	2023	Yes	3 RCT 9 cohort	612	Neither CA nor FA seem to have a substantially impact on periodontal health when appropriate oral health promotion programs are established.
Raghavan et al (9)	2023	Yes	5 RCT 9 NRSI	1239	CA is associated with less plaque accumulation than CF orthodontic appliances.
Pamplona et al (10)	2024	No	2 RCT 1 Cross-sectional 5 Cohort studies	411	CA help maintain a healthier and more balanced oral microbiome, both in terms of microbial health and composition, than fixed appliances
Lucchese et al (11)	2025	No	1 RCT 1Controlled clinical trial 7 Cohort studies	305	Both treatment modalities alter the oral microbiome; however, the changes associated with clear aligners appear to be more conducive to improved oral health compared to those induced by fixed appliances

orthodontic patients who had either a fixed orthodontic appliance or a clear aligner appliance. The common feature of all studies included was the adoption of next-generation sequencing of the bacterial 16S rRNA gene to define microbial changes during orthodontic treatment. Six studies were selected: one randomized controlled trial (RCT) and five prospective studies that met the following inclusion criteria: prospective studies assessing microbiological changes with next-generation sequencing (NGS) methods in patients in good general health, involving fixed multibracket metal and removable therapy with clear aligners, and providing a clear description of the materials and

techniques used. The microbiological modifications were assessed at three levels: salivary, supragingival, and subgingival. At the salivary level, the dysbiosis was substantially similar between the two therapeutic approaches. Slightly different effects were detected at a subgingival level within fixed appliance therapy, where a minor increase of subgingival pathogens was detected. At the subgingival level, no studies with clear aligners were selected at the time of publication of this paper. On the other hand, full fixed appliances were pointed to change the microbial conditions in the short-term period. At the same time, upon completion of treatment, these modifications returned to their baseline level.

In 2023, Llera-Romero et al. performed a systematic review and meta-analysis to identify the differences related to periodontal health, oral microbiome, and white spot lesions in subjects undergoing orthodontic treatment (CAT vs. FAT). Thirty-one studies were selected, and seventeen were candidates for a meta-analysis according to the following inclusion criteria: controlled clinical trials, randomized clinical trials (RCTs), cohort studies, and observational studies (both retrospective and prospective), published or in press in English. The risk of bias was low due to deviations from the intended intervention or missing data. The risk of bias was regarded as moderate in 32% of the studies and severe in 68%. The periodontal indicators analyzed show significantly better values in patients treated with CAs, with mild to large effect sizes. Both the plaque and the bleeding index show a significant tendency to improve throughout treatment with CAs. CA patients have a lower biofilm mass compared to those treated with FAs. However, no differences were found in the percentage of patients with high counts of *S. mutans* and *Lactobacillus*. Subjects wearing clear aligners have a ten times lower risk of developing white spot lesions compared to complete fixed appliance treatment, according to their results.

In Raghavan's systematic review, they investigated whether there is a difference between plaque accumulation measured by plaque index (PI) in orthodontic patients with clear aligners and fixed metal brackets. Fourteen articles were selected, and eight were candidates for a meta-analysis according to the following inclusion criteria: patients with normal general health who required comprehensive orthodontic treatment in late mixed and permanent dentition, with no active caries lesions.

All included RCTs suffered high risk of bias in measurement of the outcome, mainly due to lack of blinding of assessors, and only one study was additionally graded high risk of bias arising from the randomization process. The included NRSIs were graded as high risk of bias, and other studies were graded as moderate risk due to confounding factors. They concluded that CA is associated with less plaque accumulation and fewer salivary-associated caries bacteria than CF orthodontic appliances. In the Crego-Ruiz (8) systematic review, the aim was to assess periodontal health maintenance and the development of gingival recessions in patients undergoing orthodontic treatment with clear aligners (CA) and fixed appliances (FA). Twelve studies were included in the systematic review. Only eight studies could be included in the quantitative analysis according to the following inclusion criteria: randomized clinical trials, controlled clinical trials, and prospective or retrospective cohort studies in which the periodontal health status and gingival recession development were assessed and compared objectively during orthodontic treatment with buccal fixed appliances (FA) and continuous arch (CA). The main limitation that arises in randomized and non-randomized studies is the blinding of the outcome assessor. Most randomized clinical trials reported a high risk of bias arising from the randomization process. Some non-randomized studies were assigned a moderate risk of bias due to the

selection of participants, as some studies began after the exposure assignment. Neither CA nor FA seems to have a substantial impact on periodontal health when appropriate oral health promotion programs are established.

In Pamplona's review (10), they analyzed the impact of clear aligners on changes in the oral microbiota compared to traditional fixed appliances. Eight studies were included in the systematic review according to the following inclusion criteria: controlled clinical trials (CCTs), where several similar individuals were randomly assigned to two (or more) groups; randomized clinical trials (RCTs); cohort studies; and observational studies, both retrospective and prospective. Several limitations in the analyzed studies affect the quality of this systematic review, including small sample sizes, short study durations, and a lack of long-term data.

Clear aligner systems appear to exert a beneficial influence on the oral microbiome, both in terms of microbial health and composition, demonstrating a more favorable effect in maintaining a balanced oral microbial ecosystem compared to fixed orthodontic appliances. In 2025, Lucchese et al. (11) performed a systematic review regarding the alterations in bacterial flora and oral health associated with aligner and fixed orthodontic therapy. Nine articles were selected for the qualitative analysis according to the following inclusion criteria: RCTs, nRCTs, cohort studies, at least 2 time points for analysis (with at least one before the beginning of treatment), at least 10 patients analyzed, trials analyzing patients treated with clear aligners or comparison between aligners and fixed therapy, trials analyzing patients with good systemic health, who were not taking medications. Several limitations in the included studies compromise the overall quality of this systematic review, including: lack of description of the appliance involved in the studies, heterogeneity of the procedure used for the microbiological analysis, no long-term follow up, none of the studies cited the presence or not of attachments, only qualitative were conducted. Both fixed appliances and clear aligner therapy are associated with oral microbiota dysbiosis, representing a disruption in microbial homeostasis. However, they concluded, the microbiological alterations observed with clear aligners appear to be more compatible with maintaining a favorable oral health status.

Quality of Systematic Reviews

The quality of the included systematic reviews was assessed using the AMSTAR 2 tool, which comprises 16 key questions (24) (25). The answers were formulated based on the analysis of the individual reviews (Table 3):

- Question 1: Did the research questions and inclusion criteria for the review include the components of PICO?

The response was positive for all the reviews examined, as all authors clearly defined these aspects in their reviews (1) (2) (6) (7) (9) (8) (10) (11)

- Question 2: Did the report of the review contain an explicit statement that the review methods were established before the conduct of the review, and did the report justify any significant deviations from the protocol?

All reviews provided a satisfactory explanation ('Yes') (1) (2) (6) (7) (9) (8) (10) (11)

- Question 3: Did the review authors explain their selection of the study designs for inclusion in the review?

All reviews (2) (6) (7) (9) (8) (10) (11), except Campobasso et al (1), fulfilled this criterion.

- Question 4: Did the review authors use a comprehensive literature search strategy?

The evaluation revealed that most reviews did not employ a comprehensive strategy, resulting in a rating of 'partially satisfactory' (PS). The others, including Pamplona et al and Lucchese et al, were classified as 'Yes' (10) (11).

- Question 5: Did the review authors perform study selection in duplicate?

Almost all the reviews showed that they adopted this practice, except Jiang et al ('No') (2)

- Question 6: Did the review authors perform data extraction in duplicate?

All reviewers except Jiang et al. performed this procedure ('Yes'), while the latter did not ('No') (2)

- Question 7: Did the review authors provide a list of excluded studies and justify the exclusions?

The reviews by Raghavan et al (9), Crego-Ruiz et al (8) provided an exhaustive list and justified the exclusions ('Yes'). Oikonomou et al (6), Llera-Romero et al (7), and Pamplona et al., on the other hand, offered partial justifications ('PS'), while Jiang et al., Campobasso et al., and Lucchese et al., did not fulfill this criterion (and').

- Question 8: Did the review authors describe the included studies in adequate detail?

Almost all reviews provided a detailed description (1)

(2) (7) (9) (8) (10) (11), except for Oikonomou et al (6), who provided only a partial one ('PS').

- Question 9: Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review?

Oikonomou et al (6) and Campobasso et al (1) again did not fully meet the criteria ('PS'), whereas all other reviews fulfilled the question entirely ('Yes') (2) (7) (9) (8) (10) (11).

- Question 10: Did the review authors report on the sources of funding for the studies included in the review?

No review reported this information, so all were rated negatively ('No').

- Question 11: If meta-analysis was performed, did the review authors use appropriate methods for statistical combination of results?

All reviews that conducted a meta-analysis fulfilled this criterion in full, obtaining a positive rating ('Yes') (1) (2) (6) (7) (9) (8) (10) (11).

- Question 12: If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?

All reviews that conducted a meta-analysis took into consideration the risk of bias and were therefore rated positively ('Yes') (1) (2) (6) (7) (9) (8) (10) (11).

- Question 13: Did the review authors account for RoB in individual studies when interpreting/discussing the results of the review?

Here, too, all reviews adequately addressed this issue, answering the question's criteria ('Yes') (1) (2) (6) (7) (9) (8) (10) (11).

Table 3. Methodological quality assessment based on the AMSTAR 2 items.

AMSTAR 2 itemS	Jiang et al. 2018 (2)	Oikonomou et al. 2021 (6)	Campobasso et al. 2021 (1)	Llera-Romero et al. 2023 (7)	Raghavan et al. 2023 (9)	Crego-Ruiz et al. 2023 (8)	Pamplona et al. 2024 (10)	Lucchese et al. 2025 (11)
Question 1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Question 2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Question 3	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Question 4	PS	PS	PS	PS	PS	PS	Yes	Yes
Question 5	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Question 6	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Question 7	No	PS	No	PS	Yes	Yes	PS	No
Question 8	Yes	PS	Yes	Yes	Yes	Yes	Yes	Yes
Question 9	Yes	PS	PS	Yes	Yes	Yes	Yes	Yes
Question 10	No	No	No	No	No	No	No	No
Question 11	Yes	Yes	No	Yes	Yes	Yes	No	No
Question 12	Yes	Yes	No	Yes	Yes	Yes	No	No
Question 13	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Question 14	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Question 15	Yes	No	Yes	Yes	No	No	No	No
Question 16	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes

- Question 14: Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review? All reviews provided a satisfactory explanation ('Yes') (1) (2) (6) (7) (9) (8) (10) (11).

- Question 15: If they performed quantitative synthesis, did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review?

Only the reviews by Llera-Romero et al., Jiang et al., and Campobasso et al. fulfilled this criterion ('Yes') (1) (2) (7), whereas the articles by Oikonomou et al., Raghavan et al., and Crego-Ruiz et al. Pamplona et al and Lucchese et al did not meet it ('No') (6) (9) (8) (10) (11).

- Question 16: Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?

Most of the reviews adequately indicated conflicts, except for Oikonomou et al (6) , who did not provide such information ('No') (1) (2) (7) (9) (8) (10) (11).

Discussion

This review of systematic reviews aimed to identify the level of evidence regarding changes that occur in the oral cavity in patients undergoing orthodontic treatment, with particular attention to changes in the oral microbiota and periodontal index. The included review's analysis showed that there are differences between the two treatments. Still, these differences are often not clinically significant in the long term, particularly when the follow-up period is at least 6-12 months or more from the start of treatment. This indicates that although there are initial advantages, the differences tend to diminish or disappear during the orthodontic treatment. The studies considered in the reviews evaluated several periodontal indices, including the plaque index (PI), the gingival index (GI), the probing depth (PPD), and bleeding on probing (BoP). Several reviews, including those by Jiang et al., Llera-Romero et al., and Raghavan et al., have reported a favorable trend for patients treated with clear aligners, in terms of reduced plaque and gingival inflammation. However, these differences were not always found to be statistically significant. In the first months of treatment, the PI was generally lower in patients with CAT than in those with FAT, probably due to the possibility of removing aligners for better home oral hygiene.

However, as observed by Campobasso et al. and Crego-Ruiz et al., these differences tend to attenuate in the long term, making the differences between the two treatment groups irrelevant (1) (8). A slight reduction in GI and BoP was also observed, as well as a minor decrease in inflammation in CAT patients; however, differences were not consistent or clinically relevant in all studies considered. Although slightly better scores were observed for patients with clear aligners, the impact on overall periodontal health seems to be limited and not decisive. Reviews that also examined the oral microbiota reported some differences between clear aligner and fixed appliance treatments, particularly in

terms of the presence of cariogenic bacteria such as *Streptococcus Mutans* and *Lactobacilli*. In general, patients with CAT show a lower proliferation of these bacteria, as noted in the reviews by Oikonomou et al. and Raghavan et al., which may explain the reduced incidence and severity of WSL in these patients (6) (9). However, even in this case, the differences observed are often modest and tend to stabilize over time. Further research and larger samples are needed to confirm these observations. The studies included by Campobasso et al. also showed that the microbiota tends to remain stable over the long term, regardless of the type of increase (1). This means that although there is a temporary change in the oral microbiota, particularly in the supragingival plaque, the overall microbial diversity does not appear to change significantly over time. At the subgingival level, both CAT and FAT appear to induce transient changes, with a slight increase in pathogen growth in patients with FAT, but no significant change in CAT patients. Therefore, the initial differences between the two groups are not clinically significant in the long-term evaluation. A key element considered in this review was the quality of the included studies, assessed using the AMSTAR 2 tool. All reviews considered the risk of bias of individual studies using different tools.

For example, Campobasso et al. applied the SBU criterion (Swedish Council on Technology Assessment in Health Care) to assess the quality of studies (1). Llera-Romero et al. used the Cochrane Risk of Bias 1 tool (RoB-1) for randomized studies and the ROBINS-I for non-randomized ones, while Pamplona et al. used the same tool for randomized trials and the Newcastle-Ottawa scale for non-randomized ones. Oikonomou et al. used the Cochrane Risk of Bias tool 2.0 for randomised studies and the ROBINS-I for non-randomised ones (6). Crego-Ruiz et al. and Lucchese et al. applied the ROBINS-I for non-randomised studies and the Cochrane Risk of Bias (RoB 2.0) for randomised ones. Finally, Raghavan et al. used the Cochrane Risk of Bias (RoB) and GRADEpro, while Jiang et al. adopted the Cochrane tool for randomized controlled trials and the Newcastle-Ottawa Scale for cohort studies, supplemented with GRADE. It is worth noting that the reviews also differed in the heterogeneity of the included studies. Differences in study designs, populations, interventions, and outcome assessment criteria contributed to significant variability between the reviews, making it difficult to compare results and draw firm conclusions on some variables directly. Some reviews, however, have attempted to explain and manage this heterogeneity using statistical methods, but the differences remain a significant limitation for the overall interpretation. Finally, although all reviews clearly defined PICO criteria, some did not employ a comprehensive search strategy or did not report predefined protocols before the evaluation was executed, as in the cases of Llera-Romero et al. and Campobasso et al (1) (7)

Furthermore, Jiang et al. did not apply duplicate methods for study selection or data extraction, thus increasing the risk of bias (2). Overall, although the reviews provided sufficient evidence to suggest

that clear aligners may promote better oral hygiene and reduce periodontal inflammation compared to fixed appliances, these differences are not clinically significant(29-30). The quality of the available evidence necessitates further studies to confirm these conclusions, particularly regarding long-term effects and their practical implications for patients.

Conclusions

This review of systematic reviews suggests that, although clear aligners may promote better oral hygiene and a temporary decrease in periodontal inflammation compared to fixed appliances, the differences are not clinically significant in the long term. Periodontal indices indicate a slight improvement in CAT compared to FAT. However, these advantages tend to diminish as treatment progresses, becoming clinically irrelevant. Regarding the oral microbiota, both treatments may cause transient changes; however, no significant changes are observed that could decisively influence overall periodontal health. Although evidence suggests potential benefits of clear aligners, the quality and heterogeneity of the reviews analyzed limit the ability to draw definitive conclusions.

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