

REMOVABLE ORTHODONTIC ALIGNERS VERSUS FIXED ORTHODONTIC APPLIANCES: A LITERATURE REVIEW.

ALINHADORES ORTODÔNTICOS REMOVÍVEIS VERSUS APARELHOS ORTODÔNTICOS FIXOS: UMA REVISÃO DA LITERATURA.

Luíza Trindade Vilela<sup>1</sup>, Taiane dos Santos Lopes<sup>2</sup>, Bruna Caroline Tomé Barreto<sup>3</sup>,  
Margareth Maria Gomes de Souza<sup>4</sup>

**Resumo**

Com intuito de pontuar os paralelos entre as técnicas ortodônticas com aparelhagem fixa e alinhadores transparentes, este estudo propôs revisar a literatura científica sobre alinhadores ortodônticos removíveis versus aparelhos ortodônticos fixos. Foram selecionados artigos de 2005 a 2021, utilizando as bases de dados PubMed, Scopus, Web of Science, Cochrane Library, Clinical Trials e OpenGrey. Os artigos abordavam temáticas como sensação dolorosa, saúde periodontal, higiene, microbiota, reabsorção radicular, qualidade de vida e efetividade do tratamento. Os alinhadores apresentaram maior aceitabilidade pelos pacientes e vantagens claras em relação à dor, higiene, qualidade de vida, reabsorção radicular e saúde periodontal, sendo inferior aos aparelhos ortodônticos fixos na efetividade do tratamento e na interferência na fala.

**Palavras-chave:** Aparelhos Ortodônticos Fixos, Aparelhos Ortodônticos Removíveis, Alinhadores Ortodônticos, Ortodontia.

**Abstract**

*In order to point out the parallels between orthodontic techniques with fixed appliances and transparent aligners, this study proposed to review the scientific literature on removable orthodontic aligners versus fixed orthodontic appliances. Articles from 2005 to 2021 were selected, using the PubMed, Scopus, Web of Science, Cochrane Library, Clinical Trials and OpenGrey databases. The articles addressed issues such as pain, periodontal health, hygiene, microbiota, root resorption, quality of life and treatment effectiveness. Aligners showed greater acceptability by patients and clear advantages in relation to pain, hygiene, quality of life, root resorption and periodontal health, being inferior to fixed orthodontic appliances in terms of effectiveness and speech capacity.*

**Keywords:** Orthodontic Appliances, Fixed; Orthodontic Appliances, Removable; Aligner Appliance; Orthodontics.

1. MSc and PhD student in Orthodontics - PPGO/UFRJ – Pediatric Dentistry and Orthodontics Department of the Federal University of Rio de Janeiro (UFRJ), Rio de Janeiro, RJ, Brazil.

2. MSc in Orthodontics - PPGO/UFRJ - Department of Semiology, Naval Dental Center (Odontoclínica Central da Marinha), Brazilian Navy, Rio de Janeiro, RJ, Brazil

3. MSc and PhD student in Orthodontics - PPGO/UFRJ – Pediatric Dentistry and Orthodontics Department of the Federal University of Rio de Janeiro (UFRJ), Rio de Janeiro, RJ, Brazil.

4. PhD in Orthodontics and Senior Professor of Orthodontics - PPGO/UFRJ – Pediatric Dentistry and Orthodontics Department of the Federal University of Rio de Janeiro (UFRJ), Rio de Janeiro, RJ, Brazil.

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## INTRODUCTION

The growing search for esthetic alternatives worldwide reflects in the significant increase in the number of orthodontic patients seeking treatment with clear aligners (1). However, traditional fixed appliances continue to be the main orthodontic appliance used (2), carrying with them all their efficiency and history of successfully completed cases.

Aligners are the category of orthodontic appliances most sought by patients due to aesthetics and comfort when compared to other types of treatments (2,3). However, aligners have limitations when compared with fixed appliances, such as in controlling root movements, intrusive and extrusive movements, and dependence on the patient's cooperation (1).

The literature have discussed about the advantages and disadvantages of using aligners and their limitations in treatment (2). The commercial companies that produce the aligners claim their effectiveness, although there is little scientific evidence of high methodological quality available (4).

Aligners are more attractive for patients due to esthetics and their practical cleaning, and for the professionals, due to the opportunity of using another working tool for conducting their clinical cases (5). However, both the patient and the professional must be aware of the limitations of treatment with these devices (6). Therefore, the professional must master the planning and carefully select the cases suitable for this type of treatment, without suppressing the patients' expectations (4).

Given the scenario, knowledge about comparisons between types of treatments, adequately approaching their risks and benefits, in addition to the complete mastery of the techniques by the professional, is paramount. Thus, the professional promotes patient's health by correcting the malocclusion, besides providing the best esthetics possible during the treatment.

Thus, this study aims to review the scientific literature on orthodontic treatment using fixed orthodontic appliances compared to removable orthodontic aligners, showing their advantages and disadvantages regarding quality

of life, pain, periodontal health, oral hygiene conditions, oral microbiota, apical resorption, and effectiveness of orthodontic treatment. We also aim to find scientific evidence to clarify issues relevant to the results obtained with treatment with removable orthodontic aligners compared to fixed orthodontic appliances.

## LITERATURE REVIEW

Eligibility criteria were defined based on studies that compared orthodontic treatments using fixed braces with clear aligners. No restrictions were applied. Observational, interventional and review studies were included. Expert opinions, editorials, letters, and case series were excluded.

The scientific literature was reviewed in the following databases: PubMed, Scopus, Web of Science, Cochrane Library, Clinical trials and OpenGrey. The search strategy was initially developed for MEDLINE (PubMed) using MeSH terms when possible, input terms and free terms (they included the combination of the terms "orthodontics," "malocclusion", "therapeutics", "patients", "aligners", "invisible appliances", "orthodontic brackets", "orthodontic appliances" and their derivatives, adapted for each database and for each language) further adapted to each database's syntax rules. Boolean operators "OR" and "AND" were combined to optimize searches. There were no language restrictions. Manual removal of duplicates was done by three reviewers (LTV,TSL and BCTB). Searches were conducted in July 2021. Full articles published between 1971 and 2021, in English, Portuguese and Spanish were selected. Articles that did not meet the eligibility criteria were excluded at this stage. Selected articles were then read in full to confirm eligibility. Articles in languages other than English were translated using the Google Translate tool. Articles that did not present the proposed study design, those that did not address the researched topic and/or were not retrieved in their full version were excluded.

In total, 1441 articles were retrieved (PubMed = 374, Scopus = 72, Web of Science = 732, Cochrane Library = 243, Clinical trials

= 18 and OpenGrey = 2). After removing duplicates, and reading titles, abstracts, and articles in full, 39 papers were chosen to compose this review.

## **Influence on quality of life**

Oral health and quality of life are issues that can be interlinked. Furthermore, they are fundamental questions for the elaboration of the adequate treatment plan for the patient; however, the professional should consider the perception and needs inherent to each patient (7).

Quality of life occupies a priority position in several therapeutic modalities, including orthodontic treatment. Studies comparing the influence of the three types of orthodontic treatment (conventional, lingual and aligners) on the quality of life of patients reported that patients, when undergoing therapy with aligners, report higher quality of life scores, followed by fixed lingual and conventional appliance groups (6). According to Shalish et al., the lingual appliance was associated with more intense pain, greater consumption of analgesics, greater oral and general dysfunction (phonation, swallowing and mouth opening), besides a longer and more difficult recovery (2).

On the other hand, a survey showed both advantages and disadvantages of the treatment with aligners and with conventional appliances (8). Regarding speech, patients reported greater difficulty in treatment with aligners. However, these treatments reported better results regarding the feeding aspect, showing a better chewing ability, without restriction on the amount and type of food with the use of aligners. Treatment with conventional appliance, in turn, caused a greater number and extension of ulcerations in the oral mucosa. Effects on daily routine, analgesic use, and overall satisfaction with treatment did not differ significantly between groups.

Melo et al. described that the group treated with aligners presented speech alterations at the beginning of the treatment, according to an evaluation conducted by a speech-language pathologist. In the self-assessment, patients reported the perception of speech modification

with both treatment approaches. This shows the importance of the Orthodontist alerting patients about speech alterations, reiterating their temporary nature, regardless of the therapy used (9).

Thus, treatment with removable aligners is not necessarily more pleasant, but more tolerable, since it satisfies the patient's needs regarding feeding, teeth cleaning, smile and, consequently, social relationships (8,10).

## **Pain perception**

Pain or discomfort is a common side effect during orthodontic treatment. Although subjective, pain is influenced by factors such as age, sex, and culture. Besides, it may be influenced by physiology and emotional factors, and validated questionnaires are used as a method to assess patients' pain perception (11).

A systematic review conducted by Pereira et al. evidences that patients treated with removable aligners experience less pain and discomfort during orthodontic treatment when compared with those treated with fixed orthodontic appliances (12). Other studies corroborate the study by Pereira et al. (12), such as Almasoud (13), who, through the technique of passive self-ligating fixed orthodontic appliances, indicates that patients treated with removable aligners reported significantly less pain and used a lower dose of pain relief medication compared to those treated with fixed devices (13).

During the first days of treatment, orthodontic patients treated with aligners reported lower levels of pain compared to those treated with fixed braces (13-15). Fujiyama et al. (16) add that after treatment was completed, patients reported reduced pain in treatment with removable aligners compared to the Edgewise fixed orthodontic appliance, when analyzing the entire duration of the treatment.

However, the studies evaluated point out some limitations and suggest further studies with better methodological qualities to assess the comfort of using aligners and orthodontic fixed appliances (1,12).

## Periodontal health

Orthodontic treatment using fixed appliances difficults oral hygiene, which allows for retention sites of oral biofilm and, consequently, development of white spot lesions, caries, and periodontitis (17-18), which compromise the balance of oral health.

Haili Lu et al. found that orthodontic aligners had lower rates of gingival bleeding and plaque accumulation, besides not having statistical significance in the status of the gingival index and probing depth compared to the fixed appliance. This meta-analysis found the aligners for maintaining periodontal health to be more favorable (20). Other studies corroborate these findings, such as the one by Jiang (21). The microbial plaque index of individuals with fixed orthodontic devices was significantly higher during the initial treatment period (19).

According to Chhibber et al, the choice of orthodontic appliance has little influence on periodontal health parameters, since there is no evidence of any distinction between levels of oral hygiene when comparing patients treated with aligners, self-ligating brackets, or conventional ones after eighteen months of orthodontic treatment (22). Despite the short term, individuals treated with aligners had better oral hygiene conditions.

However, due to the methodological limitations of the articles reviewed, such as heterogeneity regarding the type of fixed appliances (oral or lingual) and variation in the eligibility criteria of the studies, it is still necessary to confirm the results found through randomized clinical trials (20,21). Likewise, Jiang et al. recommend high methodological quality randomized clinical trials, since the evidence investigated was of medium reliability (21).

## Oral hygiene conditions

A study highlights the importance of prophylaxis performed by professionals associated with motivation and regular reinforcement for the proper control of dental biofilm during orthodontic treatment. Prevention and follow-up procedures help prevent periodontal disease and maintain a balanced periodontal health, regardless of

the type of device used during orthodontic treatment (23).

Miethke's study corroborates these findings and evidences an improvement in oral hygiene during the research evaluations, which is attributed to the support provided by professionals through numerous episodes of oral hygiene instruction and frequent motivation (19).

Patients unable to maintain oral hygiene during orthodontic treatment have several consequences, one of which may be the appearance of white spots – the beginning of carious lesions. A prospective randomized clinical trial investigated the relationship between therapy with removable aligners and the development of white spot lesions and compared this therapy with treatment with fixed orthodontic appliances (24).

In short, they concluded that both forms of treatment caused enamel demineralization. Patients who used aligners developed white spot lesions that were larger in extension and more superficial, whereas the fixed appliance group developed a greater number of new lesions with greater severity and smaller in size. Greater microbial plaque accumulation was found in the conventional group compared to aligners (24).

## Oral microbiota

During orthodontic treatment, orthodontic forces are applied so that the tooth moves, which generates an inflammatory response in the tissues. Another factor that can cause gingival inflammation is the accumulation of microbial plaque (25). Therefore, it is important to investigate the microbiota during orthodontic treatment.

According to Mummolo et al., orthodontic treatment with aligners allows the maintenance of adequate oral hygiene, compared to braces with brackets. The study evaluated that, after six months of orthodontic treatment, the concentration of *Streptococcus mutans* in the group using aligners indicated only 8% of participants with high concentrations of *Streptococcus mutans*, compared to 40% of participants with fixed devices. This result indicated the need for additional strategies to

control microbial plaque (26).

Gujar et al. evaluated levels of the cytokines, IL-1a, IL-1 $\beta$ , IL2, IL-6, IL-8, and TNF-a, in the crevicular gingival fluid. Some alterations were observed after three weeks; however, only slight differences were evidenced in the alterations of the levels of cytokines both in the group evaluated with conventional fixed orthodontic appliance and with aligners (27). The study by Zeffa et al. corroborates these findings evaluating electrolyte imbalances and reporting no significant changes in orthodontic patients with microbial plaque control, treated either with aligners or with metallic fixed appliances (28).

According to Wang et al., there is no significant difference between orthodontic treatment with fixed devices and aligners, since both resulted in dysbiosis of the oral microbiome (29). By analyzing the composition of the microbiome and functional aspects, the aligners did not show superior performance compared to treatment with fixed devices. This finding suggests that the fact that most of the population studied presented adequate periodontal health, when this variable is associated with the use of aligners, may not be related to the presence of microorganisms.

## Apical resorption level

One of the side effects most described in the literature and also one of the most undesirable resulting from orthodontic treatment is the rounding of the apex of the teeth roots and, more rarely, severe apical root resorption (30). Therefore, the importance of evaluating the process of tooth resorption during orthodontic treatments is unquestionable, whether with aligners or fixed appliances.

According to a study that used cone beam computed tomography (CBCT) as a diagnostic method, the prevalence of apical root resorption was lower in patients with aligners (56.30%) compared to patients with fixed appliances (82.11%). Furthermore, the severity of root resorptions was lower in cases treated with aligners (31).

In the study by Li et al., the maxillary and mandibular central incisors were the most affected teeth in the treatment with aligners

(31). On the other hand, in fixed appliance therapy, the upper and lower lateral incisors were the most affected (31). The advantage of this study is that the evaluated treatments were selected for presenting the same level of complexity to avoid bias and that the evaluation was conducted in a three-dimensional way using CBCT.

Yi et al. conducted a study that corroborates these findings; however, the assessment was conducted with panoramic radiographs, a two-dimensional examination. Furthermore, a reported finding was that the duration of treatment proved to be an important element to justify the greater resorption found in treatments with fixed appliances. The variables sex, age, skeletal pattern, and degree of malocclusion did not interfere with the occurrence of resorption (32).

The conclusion of a systematic review and meta-analysis is in line with most studies described in the literature in which treatment with aligner does not totally eliminate the possibility of apical resorptions but reduces the risk of its occurrence compared to the fixed appliance, a characteristic of great importance (33,34).

## Effectiveness of orthodontic treatment

One of the main factors that must be analyzed when comparing removable aligners and fixed appliances is the effectiveness of the results.

Thus, a study considered variables such as lip symmetry, smile index, smile scale, oral corridor, and gingival exposure in the composition of the smile. As a result, the treatment with the aligner showed better performance in two variables that determined the position (1.26 mm) and inclination (2.09°) of the upper incisors. On the other hand, treatment with traditional fixed appliances resulted in a more effective change in the smile and efficiency in improving the variables that quantify the post-treatment smile result (35).

Gu et al. evaluated the outcome and duration of treatment between the groups of aligners and fixed appliances. The authors showed that both forms of treatment are capable of correcting

malocclusion; emphasizing that treatment with aligners was completed 5.7 months earlier (36). The authors, however, consider that aligners may not be as effective as fixed appliances in the full correction of malocclusion, corroborating the aforementioned study (36). According to Henessy et al., comparing the correction of incisor protrusion in both treatments, had no significant results (37).

According to Ke et al., aligners may not be as effective as fixed appliances in establishing adequate occlusal contacts, controlling tooth torque, increasing transverse width and retention. However, patients treated with aligners completed the treatment with a statistically shorter duration compared to patients who received the conventional appliance (38). Furthermore, Greppe and Sigilião concluded that the treatment with aligners has limitations both in the finalization phase and in the use of anteroposterior discrepancies (5).

The results suggest that aligners can provide successful alignment, but they have difficulties in achieving positive results in more complex treatments. Furthermore, studies show that cases treated with aligners are more susceptible to recurrences, which can be explained by the tilting mechanism compared to tooth movement achieved with conventional fixed appliances (3,6). According to Kassam et al. in a systematic review, the use of invisible aligners did not show a significant difference in treatment time compared to conventional appliances (3,6).

Pithon et al. conducted a study in which they concluded that the invisible aligners were deficient when considering anterior, posterior, and vertical corrections compared to fixed orthodontic appliances. This is due to the fact that fixed appliances allow vertical adjustments within the limits of 0.5 mm for intrusion or extrusion of a tooth when necessary, considering that these types of movements are difficult to perform with aligners. Furthermore, it has the disadvantage of patient cooperation, since the success of the treatment depends on the patient using the device for the recommended period (3).

Djeu et al. point out that the lack of occlusal contact after the treatment with aligners is completed due to the covering of the teeth by acetate, difficulting the stability of the occlusion,

which does not occur in the fixed appliance, since the brackets are glued to the buccal or palatal/lingual surface, allowing the occlusal contacts without interference (39). Another limitation is presented in the study by Giancotti et al., in treatment, using aligners, of Class II malocclusion with first premolar extractions. The alignment phase showed satisfactory results, but the space closure phase resulted in tilting of the crowns and lack of proper root positioning, thus requiring a new fixed appliance phase (40).

In short, removable aligners are effective in promoting dental alignment, but they have clinical limitations compared to fixed appliances, such as in cases of extractions, intrusive and extrusive movements. Therefore, this system corrects light overbites and crowding, being a viable choice in cases of recurrence of a fixed anterior orthodontic treatment (3).

## RESULTS

Table I shows the studies selected in this literature review and the criteria considered in the respective studies for the assessment of the topic of removable orthodontic aligners compared to fixed orthodontic appliances.

## CONCLUSION

Given these perspectives, we concluded that treatment with removable aligners is more tolerable, resulting in a better quality of life for patients. Quality of life includes the consumption of analgesics, oral dysfunction, time, and difficulty in recovering from injuries, hygiene, nutrition, and speech. It is considered more tolerable regarding feeding, hygiene, and speech according to the studies analyzed. It is noteworthy that during the initial days of treatment, patients using removable aligners reported lower levels of pain compared to those undergoing treatment with fixed braces. Pain studies considered age, sex, and culture, as well as pain physiology and emotional factors.

The occurrence of greater accumulation of microbial plaque was found in the group that used fixed braces, which occasionally can generate better indexes of periodontal health in patients who use aligners, such as papillary bleeding index, bacterial plaque index, and

Table 1. Distribution of studies on the topic of removable aligners compared to conventional orthodontic appliances.

Author and Year	Influence on quality of life	Pain perception	Periodontal health	Oral hygiene conditions	Oral microbiota	Apical resorption level	Effectiveness
1. Cardoso et al. (2020)							
2. Shalish et al. (2012)							
3. Pithon et al. (2019)							
4. Kassam et al. (2020)							
5. Greppe et al. (2017)							
6. AlSeraidi et al. (2021)							
7. Bendo et al. (2014)							
8. Alajmi et al. (2020)							
9. Melo et al. (2021)							
10. Lin et al. (2016)							
11. Bergius et al. (2000)							
12. Pereira et al. (2020)							
13. Almasoud et al. (2018)							
14. White et al. (2017)							
15. Zancajo et al. (2020)							
16. Fujiyama et al. (2014)							
17. Zachrisson et al. (1971)							
18. Boyd et al. (1989)							
19. Miethke et al. (2005)							
20. Lu et al. (2018)							
21. Jiang et al. (2018)							
22. Chhibber et al. (2017)							
23. Madariaga et al. (2020)							
24. Albhaisi et al. (2020)							
25. Castroflorio et al. (2017)							
26. Mummolo et al. (2020)							
27. Gujar et al. (2019)							
28. Zeffa et al. (2020)							
29. Wang et al. (2019)							
30. Weltman et al. (2010)							
31. Yuan et al. (2020)							
32. Yi et al. (2018)							
33. Mohammed et al. (2020)							
34. Gandhi et al. (2020)							
35. Christou et al. (2020)							
36. Gu et al. (2017)							
37. Hennessy et al. (2016)							
38. Yunyan et al. (2019)							
39. Djeu et al. (2005)							
40. Giancotti et al. (2006)							

probing depth. However, due to the limitations of the studies evaluated, it is necessary to confirm the results found. There is controversy regarding the microbiota, whereas some claim greater presence of pathogenic components in individuals who use the fixed appliance, others conclude that there are no significant changes between treatments.

Regarding the occurrence of root resorption, treatment with an aligner presents a lower risk of resorption compared to the fixed appliance.

Moreover, aligners are effective in tooth alignment and leveling; however, they have clinical limitations compared to the fixed orthodontic appliance, such as establishment of adequate occlusal contacts, control of tooth torque, increase in transverse width, use in anteroposterior discrepancies, phase of finishing and intrusive and extrusive movements. Therefore, aligners are a viable choice in cases of recurrence of an anterior fixed orthodontic treatment, but it can cause inclinations in cases that require greater translation movement of the teeth, which cause recurrences.

The authors declare no conflicts of interest.

#### **Corresponding Author:**

Luíza Trindade Vilela

Address: Rua Prof. Rodolpho Paulo Rocco, 325 - Cidade Universitária da Universidade Federal do Rio de Janeiro, Rio de Janeiro - RJ, Brazil. Post Code 21941-617

Email: luizavilela@ortodontia.ufrj.br

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