



Effect of Orthodontic Treatments by Dental and Periodontal Health Aligners: A Literature Review

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Abstract

Treatments with aligners have many advantages over conventional orthodontic appliances, related to their aesthetic appearance and the comfort provided. This largely explains the proven enthusiasm of orthodontists and their adult patients. Aside from the comfort that accompanies the use of these aligners, a real investigation into their impacts has proven necessary. We conducted this literature review to review the state of knowledge concerning the effect of orthodontic treatments with aligners on dental and periodontal health. The electronic search for this review was carried out on the following databases: “PubMed” “Cochrane” “Science Direct” “Springer” and “Google Scholar”, including articles published between 2010 and 2021. At the end of the initial search, 9641 references were identified on the various databases and 57 articles were retained. After the full reading, five systematic reviews, three meta-analyses, three randomized clinical trials as well as prospective and retrospective studies were found. Results show that maintaining good periodontal health is facilitated by orthodontic aligners. Compared to conventional systems, many studies have found lower periodontal index values (bleeding on probing, gingival index, papillary bleeding index, probing pocket depth) during treatment, as well as relatively stable levels of periodontal-pathogenic and cariogenic micro-organisms and finally fewer enamel decalcifications. Root resorption remains a risk associated with orthodontic treatment with aligners, as in treatment with fixed appliances. Whatever the type of orthodontic appliance, education and motivation in adequate oral hygiene is the keystone to preventing dental demineralization and the occurrence or complication of periodontal disease.

Subject Areas

Dentistry

Keywords

Orthodontics, Dental Health, Periodontal Health, Aligners

1. Introduction

In orthodontics, the growing demand of adult patients for treatment has largely justified the development of a therapeutic arsenal that meets their aesthetic requirements. Therapeutic alternatives such as ceramic brackets or lingual orthodontics have been developed in order to best respond to this aspect of treatment. More recently, the use of thermoformed gutters, so-called aligners, has now been imposed, thus making it possible to cross a new perspective, in this case that of invisibility. Indeed, the idea of using an aligner was introduced in 1946, when Kesling designed a “tooth positioning appliance” to gradually move the badly aligned teeth. [1] In 1997, Align Technology (Santa Clara, California) adapted and incorporated modern technologies to introduce treatment with aligners making the concept of Kesling an achievable orthodontic treatment option. [2] In 1999, Align Technology released its invisalign alignment system, as a removable appearance capable of gradually moving teeth using digital planning providing the desired objectives and results. [3] Thus, by retracing the evolution of orthodontic appliances over the past 100 years, we can see the advent of more aesthetic appliances, less bulky and capable of moving teeth with precision while respecting physiological displacement, but also more hygienic compatible with the preservation of the health of the dental and peri-dental system. [4] Although the aligners have been praised as aesthetic, comfortable and harmless, for the treatment of adult patients, only a few clinical trials have focused on their possible side effects. [5] Thus, considering that the teeth and the gingiva are covered almost all day by the aligners, it is important from a clinical point of view to have a good judgment concerning the impact of the aligners on the teeth and the periodontium during the treatment. Although aligners have been praised as aesthetic, comfortable and harmless, for the treatment of adult patients, only a few clinical trials have focused on their possible side effects. Thus, considering that the teeth and the gingiva are covered almost all day by the aligners, it is important from a clinical point of view to have a good judgment concerning the impact of the aligners on the teeth and the periodontium during the treatment. [6]

The objective of this work was to conduct a structured literature search to identify the available scientific evidence regarding the effects of orthodontic aligners, in comparison with conventional orthodontic systems, on dental and periodontal health, in this case, the carious risk, the risk of root resorption as well as periodontal problems.

2. Materials and Methods

This is a literature review based on primarily electronic bibliographic research to

provide an update on the state of knowledge regarding the effect of orthodontic aligner treatments on dental and periodontal health. The data collection for this literature review was carried out through electronic search on PubMed, Cochrane, Springer, Science Direct and Google Scholar, along with a manual search of published literature for more comprehensive research. The “manual” search strategy has made it possible to collect articles, related to the themes studied, that would have escaped electronic research.

On the various search, we used the following keywords:

- orthodontic appliance removable, Oral health, Periodontium, Aligner, Dental health, Periodontal health, Invisible orthodontic appliances, Teeth, tooth, Parodontium.

These words were used separately and interchangeably to identify articles for post-inclusion analysis.

- For PUBMED, we used the keywords present in the MeSH, according to the following search equations:

1) ((Orthodontic Appliances, Removable [MeSH Terms]) OR (Invisible orthodontic appliances [MeSH Terms])) AND (((Periodontal health [MeSH Terms]) OR (Periodontium [MeSH Terms])) OR (Parodontium [MeSH Terms])).

2) ((Orthodontic Appliances, Removable [MeSH Terms]) OR (Invisible orthodontic appliances [MeSH Terms])) AND (Dental health [MeSH Terms]) OR (oral health [MeSH Terms]) OR (teeth [MeSH Terms]) OR (tooth [MeSH Terms])).

The inclusion criteria: Articles in English published between 2010 and 2022, Articles dealing with different orthodontic alignment systems, Systematic reviews and meta-analyses, Clinical trials, Retrospective and prospective studies, Literature review, review and refinement, *in vitro* experimental studies.

The exclusion criteria: Editorials and expert opinions. Duplicate articles.

- Articles dealing with the use of aligners as restraints.
- Articles dealing with the use of finishing aligners at the end of processing by fixed devices.

3. Results

At the end of our search, we initially identified 9643 references, of which 4100 were published between 2010 and 2022. We selected 665 articles after reading the titles and abstracts, taking into account their relevance. (**Figure 1**)

60 articles met the predefined inclusion criteria. After a complete reading of the texts in order to identify articles that were not relevant to the subject, 58 articles were definitively retained for our review according to the following distribution: 3 Meta-analysis; 5 Systematic reviews; 4 Randomized clinical trial; 24 Prospective study; 5 Retrospective study; 7 Literature review; 3 Case report; 1 *In vitro* study; 2 *In vivo* studies; 4 Cohort studies; 1 Pilot studies.

At the end of this, we performed a critical reading of the selected articles, in order to extract the scientific data corresponding to the two themes.

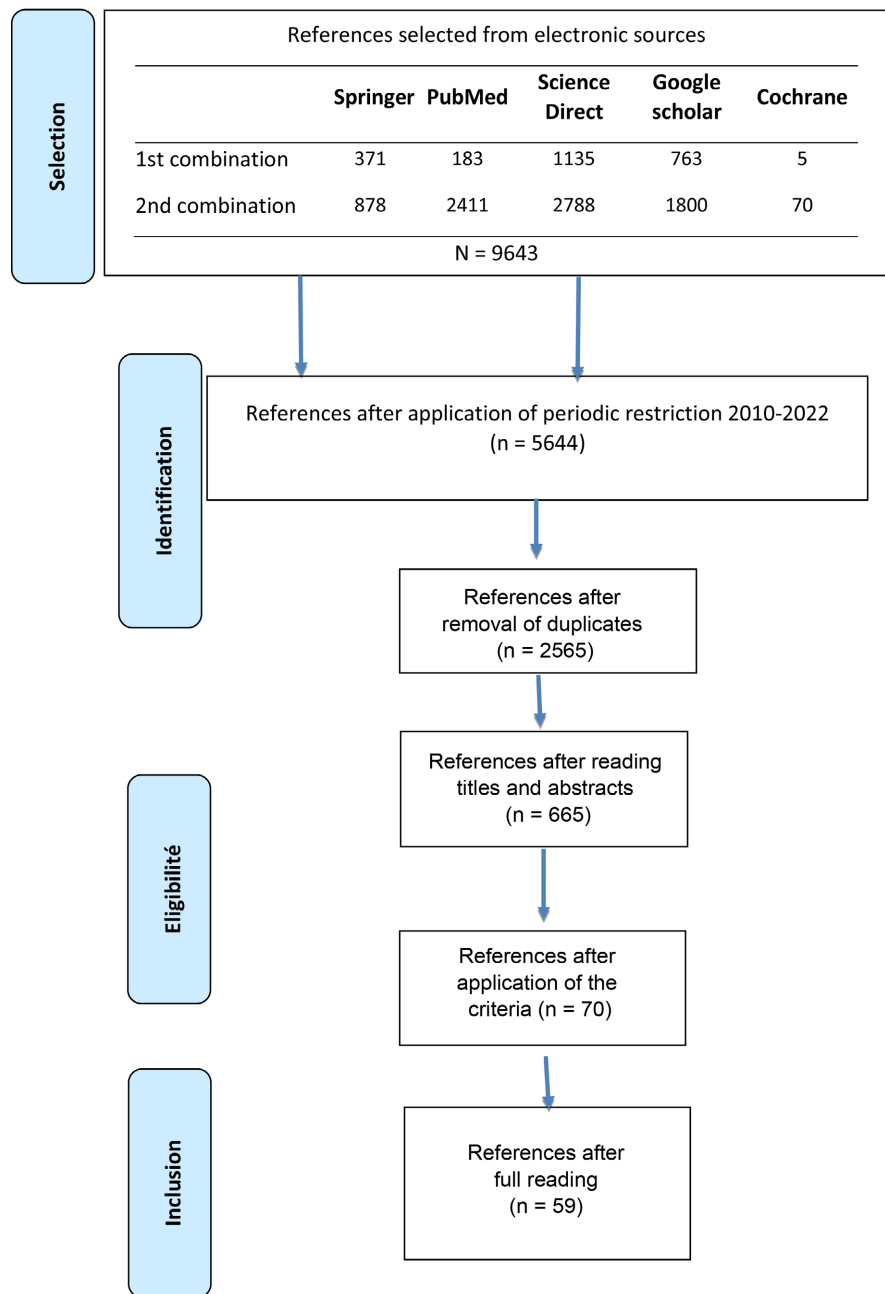


Figure 1. Search strategy diagram.

4. Discussion

Orthodontic treatment with aligners has been introduced in the last decades to meet the aesthetic and comfort requirements of adult patients. This treatment is done with removable thermoplastic aligners covering all the teeth and part of the marginal gum line. They gradually move the teeth into the desired position. In the beginning, aligners were used for mild to moderate orthodontic tooth movements. Thanks to their mechanical properties and the evolution of technology, aligners have gradually been adapted to the correction of more complex malocclusions. [1]

Until 2005, few clinical studies evaluating the effects of aligner treatments on dental and periodontal health were published. These publications have mainly focused on case reports, case series studies and description of their clinical use.

This is how our bibliographic search revealed a systematic review published in 2015, 3 meta-analyses published in 2018 and 2019, 4 systematic reviews published between 2019 and 2020 than 3 randomized clinical trials published in 2015, 2018 and 2020.

The aim of our work was to analyze the orthodontic literature, emphasizing the state of knowledge concerning the effects of aligner treatments on dental health (risk of caries and root resorption) and on periodontal health (Periodontal indices).

The bibliographic research was carried out using the computer tool. The aim was to encompass a significant number of publications. The publications listed there were mainly in English. It should be noted that PubMed was the most accessible, practical and efficient engine, using MeSH and providing different filters

We have chosen to apply a restriction on the publication date of the articles reviewed since 2010, in order to assess the recent data relating to this technique, which is constantly evolving.

We excluded references reporting the use of aligners as retainers and articles dealing with the use of finishing aligners at the end of treatment with fixed appliances, due to the limited duration of their stay in the mouth, but also to eliminate the bias related to the impacts of conventional orthodontic treatments on dental and periodontal health.

4.1. Effect of Orthodontic Aligners on Dental Health

4.1.1. Modification of the Oral Flora

The saprophytic bacterial microflora, present in the oral cavity, contributes to the health of the host by preventing infections by exogenous, potentially pathogenic microorganisms. It thus offers resistance to the colonization of these parasitic species, and regulates the inflammatory response to commensal bacteria in the oral cavity. [7]

The prospective study by Mummolo *et al.* (2020) showed that only 8% of participants wearing aligners versus around 40% of participants wearing brackets showed elevated levels of Streptococcus. Mutans after 6 months of treatment and only 2.5% of patients treated with aligners versus approximately 37.5% of those with brackets showed elevated levels of lactobacilli with a tendency for plaque index to increase over time in patients treated with brackets. [7]

4.1.2. Development of Pre-Carious Lesions and Caries

Orthodontic appliances, whatever the type, fixed or removable, complicate the self-cleaning of dental surfaces by the lips, cheeks, tongue and limit the beneficial effect of salivary clearance. [5]

Indeed, during orthodontic treatment, in general, the increased accumulation

of bacterial plaque leads to an increased susceptibility to caries, and thus, a susceptibility to the development of white lesions of the enamel or even dental decalcifications. [7] [8]

4.1.3. Root Resorptions

Root resorptions are a possible and well-documented side effect of any orthodontic treatment. Etiological factors have not been clearly identified, but resorption appears to be associated with both biological variation and treatment methods. [9]

A literature review Tamer *et al.* (2019), concluded that root resorption is always a risk associated with orthodontic treatment, whether by aligners or fixed appliances. [10]

Also, the retrospective study carried out by Li *et al.* (2020), concluded that the prevalence and severity of apical root resorptions in patients treated with aligners were lower than those in patients treated with fixed appliances. [11] [12]

4.2. Effects of Orthodontic Aligners on Periodontal Health

Periodontal disease is an inflammatory disease that affects the supporting tissues of the teeth. Biofilm accumulation and quantitative and qualitative changes in oral microbiota are the main factors associated with the development of gingivitis and periodontitis. Fixed and removable orthodontic devices are local factors favouring the accumulation of biofilm and the adhesion of periodontal pathogenic bacteria. [5]

4.2.1. Modification of the Periodontopathogen Bacterial Flora

The oral cavity, like all the surfaces of the body, is colonized by a bacterial flora, called commensal, whose role is to protect it against pathogens Lombardo *et al.*, (2017), showed in their study that a complex community of microorganisms exists on the surface of the teeth of patients treated with aligners, in a polymeric matrix of bacterial origin. [13]

However, a prospective clinical and microbiological study, conducted by Levri, Mangano, *et al.* (2015) reported that PCR (Polymerase Chain Reaction) showed a higher level of bacteria in patients treated with a fixed orthodontic appliance compared to patients treated with aligners. [14] [15]

4.2.2. Modification of Periodontal Indices

The evaluation of the periodontal status is essentially done according to clinical criteria relating to: The presence of plaque, Inflammation, Bleeding on probing, The depth of periodontal pockets or the level of attachment Srinath *et al.* (2016), in a prospective study, reported that treatment with aligners was found to be associated with good periodontal health, given the decrease in the accompanying gingival index, pocket depth and bleeding. [16]

4.2.3. Periodontal Health Status in Patients Treated with Aligners

The multi-bracket orthodontic treatment presents, despite its effectiveness, a

permanent constraint to the maintenance of rigorous oral hygiene. It thus promotes the formation of dental biofilm constituting a threat to the periodontium. A prospective histological study by Hăntoiu *et al.* (2015) concluded that fixed orthodontic appliances made oral hygiene methods more difficult, thus preventing the complete mechanical removal of dental plaque and consequently the accumulation of dental biofilm justifying the increased risk of dental disease, gingival inflammation and periodontal reactions. [16]

4.2.4. Peculiarities of Adolescent Patients with Aligners

Adolescence is characterized by a high risk of dental and periodontal problems. Indeed, from puberty, hormonal and psychological changes occur, resulting in gingivitis, and even periodontitis. Thus, the prospective study conducted by Abbate *et al.* (2015), concluded that adolescents fitted with aligners systems had better periodontal health values compared to adolescents fitted with fixed orthodontic appliances, after the same duration of treatment. [17]

4.2.5. Particularities of Patients at Risk of Developing Periodontal Disease

It is established that orthodontic treatment improves periodontal prognosis; well-aligned teeth retain less plaque and tartar. [18]

Numerous studies have shown that orthodontic treatments with aligners, compared to multi-bracket treatments, allow the maintenance of better periodontal health, due to the facilitation of oral hygiene procedures. Therefore, aligners may be recommended for patients at higher risk of developing periodontal disease. However, additional clinical studies need to be carried out in this regard. [18]-[22]

4.3. Prevention of the Effects of Aligners on Dental and Periodontal Health

The use of orthodontic aligners is accompanied by a limitation of salivary flow materializing by the cancellation of the natural cleaning properties, but also of the buffering and remineralizing effect of saliva. Also, the addition of attachments, which generally cover a considerable dental surface, hinder daily oral hygiene procedures. Therefore, preventive measures are necessary to accompany aligner treatments by aligners. [23]

- **Dietary advice:** Harris *et al.* (2012), in a systematic review, reported that orthodontists advise patients with orthodontic appliances to avoid cariogenic diets, snacking, and sticky foods. [24]
- **Oral hygiene:** Before beginning orthodontic treatment, regardless of the appliance, in this case aligners, patients must be informed and educated on the basic principles of oral hygiene to be followed. Hammad *et al.* (2019) reported in a randomized clinical trial that many patients do not remove their aligners when drinking soft drinks. This situation allows liquids to accumulate under aligners, and on enamel creating decalcifications. [23]
- **Cleaning the aligners:** Indeed, if the aligner is insufficiently or not cleaned,

the porosity of the plastic material will increase plaque retention to give a cariogenic effect. [7]

An *in vitro* study by Ghazal *et al.* (2019) showed that four cleaning methods resulted in a significant decrease in yeast cells associated with acrylic plates compared to the control group (soaking in distilled water as a control). Yeast reduction percentages were 89.9%; for brushing, 95.8% for using chlorhexidine; 99.9% for ultrasonic cleaning and 100% for using denture cleaning tablets. [25]

5. Conclusion

Due to the growing interest in aesthetic appearance, aligners represent an alternative to conventional fixed orthodontic treatments, especially in adult patients. Through this literature review on the evaluation of the effects of orthodontic aligners on dental and periodontal health, namely the risk of caries, the risk of root resorption as well as periodontal problems, it appears that aligners contribute to the maintenance of good periodontal health compared to fixed orthodontic appliances. Indeed, orthodontic treatment with aligners facilitates oral hygiene. Thus, the values of the periodontal indices (bleeding on probing, gingival index, papillary bleeding index, depth of the pocket on probing) are lower during orthodontic treatment with aligners according to several studies. Aligners should be considered an optimal treatment alternative for adolescents and patients at potential risk of developing periodontal disease. The cariogenic incidence during orthodontic treatment with aligners also remains lower. Moreover, root resorption remains associated with orthodontic treatments using aligners, just as much as treatments using conventional fixed appliances.

Conflicts of Interest

The authors declare no conflicts of interest.

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