

Editorial

Oral Microbiota Changes during Orthodontic Treatment

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Abstract

Orthodontic treatment has become increasingly popular due to its benefits in improving facial and smile aesthetics, self-esteem and the function of the stomatognathic apparatus. However, orthodontic appliances make it more difficult to brush teeth effectively, as they interfere with tooth brushing and facilitate the accumulation of dental plaque (biofilm), which induces a quantitative and qualitative change in the oral microbiota. It can cause several adverse effects, such as gingivitis, periodontitis, white spot lesions (WSL), caries and halitosis, induced by an increase in periodontopathogenic and cariogenic bacteria. Therefore, this article resumes the main findings on the changes in the oral microbiota induced by different orthodontic appliances (removable, fixed and clear aligners) and gives some practical strategies in order to reduce the impact and/or incidence of local dental/periodontal complications.

Keywords: orthodontic treatment; oral microbiome; gingivitis; caries; periodontitis; white spot lesions; orthodontic removable appliances; orthodontic fixed appliances; aligners

1. Introduction

Humans are biological units called “holobiont” which is an eukaryotic multicellular organism that includes a community of symbiotic microbial residents called microbiome [1]. Oral microbiota colonizes a heterogeneous environment composed by different surfaces such as teeth, tongue, lips, cheek, gingival tissues, epithelial sulcus, hard and soft palate [2–4]. The balance established between the microbial species and the host organism favors the maintenance of a state of health, while the loss of this balance (dysbiosis) is associated with a state of disease [1]. Recent evidence shows that dysbiosis may impact general health and may be associated with different oral mucosal diseases [1,5,6].

After colonization and maturation on the oral surfaces by the microbiota during childhood, the biological alterations that the host individual undergoes during life can alter the balance between the different microbial communities [7]. These biological alterations may be related to growth, hormones, a reduction in salivary flow rate, gingivitis or periodontitis, diet, smoking and poor oral hygiene [8–11]. These factors may favor the breaking of the symbiotic equilibrium and the predominance of few microbial species inducing a state of disease [12].

Fixed and removable orthodontic appliances may influence oral microbiota composition through two mechanisms: (1) plaque accumulation and (2) interference with oral hygiene. More specifically, a quantitative and qualitative alteration of the oral microbiota have been related to orthodontic treatment since these appliances cover a vast tooth surface [13–15]. The accumulation of food residues, bacterial plaque and the increased difficulties in maintaining a good oral hygiene by the patients constitute the main

risk factors for the onset/exacerbation of tooth caries and gingivitis/periodontitis [16–24].

Primary prevention strategies of tooth caries and periodontal diseases related to oral dysbiosis mainly consist in the use of topical fluoride, implementation of food hygiene (reduction in consumption of sugary/acidic foods and drinks) and maintaining high levels of oral hygiene through domiciliary and professional mechanical plaque removal. These strategies promote a favorable microenvironment for a balanced microbiome [14,25]. Secondary prevention strategies are addressed to early identify oral complication related to dysbiosis through periodic checkups and to restore oral eubiosis maintaining good oral hygiene levels and modifying lifestyle factors such as diet and smoking [4,14,26].

Orthodontic patients, for the reasons already set out, require special attention by the clinician and should be warned of the increased risks they are exposed to due to plaque accumulation and they should be encouraged to pursue correct oral hygiene methods to prevent local complications related to oral dysbiosis.

Therefore, the aim of this paper is to provide to the clinician the current state of knowledge regarding the oral microbiota changes induced by the different orthodontic appliances (removable, fixed and clear aligners) and its modulation strategies in order to reduce the impact and/or the incidence of local tooth/periodontal complications.

2. Fixed and Removable Orthodontic Appliances Effects on Oral Microbiota

Several factors influence the oral microbiome in orthodontic patients quantitatively and qualitatively: plaque



accumulation, metal corrosion, host immunity, hormone levels and tooth movement [27]. In fact, orthodontic appliances, both fixed and removable, promote the retention of food particles and provide retention sites for dental plaque, making it more difficult to maintain oral hygiene and increasing the likelihood of developing, gingivitis, periodontitis, white spot lesions (WSL), dental caries and Bad breath [28–30]. In a study conducted by Pan *et al.* [31] comparing the composition of the oral microbiota in orthodontic patients and in subjects not undergoing orthodontic therapy, it was found that the microbial counts between the two groups of patients showed a significant increase in several periodontopathic bacteria, including *P. gingivalis*, three months after the start of orthodontic therapy. The findings of the previous study were also confirmed by other studies conducted in recent years [32–34]. Of particular interest was the study carried out by Naranjo, who evaluated the association between changes in clinical parameters and subgingival plaque in cultures of subgingival microbial samples collected from orthodontic patients, before and after bracket placement, and from control subjects, without orthodontic treatment, observing that compared to the control group and at baseline, elevated levels of *P. gingivalis*, *P. media/Prevotella nigrescens*, *T. forsythia* and *Fusobacterium* spp. were higher in patients three months after orthodontic therapy than in patients three months after orthodontic therapy. *gingivalis*, *P. intermedia/Prevotella nigrescens*, *T. forsythia* and *Fusobacterium* spp. were higher in patients three months after orthodontic treatment than in the control and baseline groups [35]. Together with the increase in periodontopathogen bacteria, an increase in the presence of *S. mutans* or *Lactobacillus*, which are responsible for the development of caries and WSL, was detected in various clinical studies with both fixed and removable appliances [28]. As observed by Klaus *et al.* [36] in a cross-sectional study performed to measure the prevalence of *Candida* spp., *S. mutans* and *Lactobacilli* in saliva and plaque, in three groups of subjects undergoing fixed orthodontic treatment — with good oral hygiene (GOH), poor oral hygiene (POH) and poor oral hygiene with white spot lesions (POH/WL) — a high prevalence of *Candida* spp. was reported in all patients, *S. mutans* and *Lactobacilli* were reported in both saliva and plaque samples, with higher values in the POH and POH/WL groups than in the GOH group, respectively. These results were also confirmed by a further study carried out by Topaloglu-Ak *et al.* [37] on a sample of 35 children with fixed appliances and 34 with removable appliances, reporting a significant increase in *S. mutans*, *L. actobacilli* and *Candida Albicans*, six months after the insertion of fixed/removable appliances with a higher prevalence in the fixed appliance group than in the removable appliance group. There are many studies confirming that the insertion of a fixed orthodontic appliance induces changes in the oral microbiota, which persist even after its removal. In fact, according to several controlled studies, the presence

of *Aggregatibacter actinomycetemcomitans* in the subgingival crevicular fluid of orthodontic patients increased 3–6 months after the insertion of the fixed appliance compared to untreated patients, with a higher subgingival prevalence of *Aggregatibacter actinomycetemcomitans* and *Tannerella forsythia* in orthodontic patients, up to 6 months after the removal of the appliance compared to untreated patients [38]. Metal brackets with helical ligatures have been observed to retain more plaque among fixed orthodontic appliances, worsening the clinical parameters of bleeding on probing and the plaque index compared to steel ligatures [18]. Self-ligating brackets have been associated with a worsening of bleeding and plaque indices, as well as an increase in gram-negative and gram-positive bacteria (mainly *Streptococci* and *Lactobacilli*), in several studies, however no significant differences were observed compared to conventional stainless-steel ligature-bonded brackets [27]. Finally, in another study, a significant increase in *S. mutans* was observed in patients with conventional brackets compared to those with self-ligated brackets more than 18 months after the start of treatment [39]. In recent decades, the importance of aesthetics has made the use of ceramic brackets very common, which have shown average counts of *P. gingivalis*, *S. mutans* and other periodontal and cariogenic bacteria to be very similar to those found on metal brackets in both posterior and anterior teeth [40]. The emergence and spread of aligners in recent years has led the scientific community to analyze all aspects of the advantages and disadvantages of this type of treatment in comparison with conventional orthodontic appliances, observing that treatment with aligners provides better control over biofilm formation and periodontal indices [41,42]. These results were also confirmed by a meta-analysis conducted by Rossini *et al.* [43] With regard to the qualitative and quantitative characteristics of the oral microbiota in patients with aligners compared to those with fixed appliances, a significant increase in the total bacterial load during both treatments was reported, with a significant increase in the amounts of those cariogenic species in the saliva of subjects with fixed appliances [44].

3. Conclusions

Patients receiving orthodontic treatment show qualitative and quantitative differences in the oral microbiome compared to untreated subjects, induced by increased retention of supra- and subgingival bacterial plaque throughout the treatment period. These changes are at the root of the main undesirable effects of orthodontic treatment, such as gingivitis, periodontitis WSL and caries. Removable appliances, due to the possibility of keeping oral hygiene levels under better control, induce a lower worsening of periodontal indices and caries incidence, and should therefore be understood as a preferred treatment option in those patients at high risk of developing gingivitis/periodontitis and WLS/caries. If optimal therapeutic results cannot be

achieved through mobile orthodontic therapy and the use of fixed orthodontics is necessary, it would be essential: to reduce the duration of treatment to a minimum and to choose the type of brackets and ligatures in relation to the patient's lower or higher susceptibility to developing pathological conditions. Therefore, in patients with a thin gingival biotype, with poor oral hygiene or who have a greater susceptibility to the development of caries, the use of elastomeric ligatures and ceramic brackets should be avoided. It would also be advisable to make the patient aware of the importance of oral hygiene during treatment and to intensify the number of check-ups in order to stop the progression, maturation and disposition of periodontopathogens and cariogenic species in the plaque, the composition of which is changed as early as the first week of treatment. In particular, thanks to their ability to reduce the formation of dental biofilm, prevent the development of caries, modulate the presence and activity of periodontopathogen bacteria and reduce halitosis in children, the latter are considered an effective way of managing plaque in all age groups, and can be a valuable ally in the management of orthodontic patients.

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Conflict of Interest

The authors declare no conflict of interest.

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