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Modifications of Oral Flora during Orthodontic Therapy and its Impact on Oral Health

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Abstract

Orthodontic therapy plays a crucial role in the correction of malocclusions and the improvement of dental aesthetics. However, emerging evidence suggests that orthodontic appliances can significantly alter the composition and balance of the oral microbiota, leading to potential implications for oral health. This paper aims to provide a comprehensive review of the changes in oral flora observed during orthodontic therapy and their impact on oral health outcomes. The oral microbiota is a complex ecosystem comprising various microbial species that interact in dynamic equilibrium with the host. Orthodontic appliances create an environment conducive to microbial colonization and proliferation, leading to shifts in microbial diversity and abundance. It can promote the overgrowth of cariogenic bacteria leading to an increased risk of dental caries and enamel demineralization. Additionally, changes in the oral microbiota composition can cause gingival inflammation, periodontal disease, and other oral complications during orthodontic treatment. Understanding the dynamics of oral flora changes during orthodontic therapy is essential for implementing effective preventive strategies and personalized oral care regimens. Incorporating measures to mitigate dysbiosis, such as improved oral hygiene practices, antimicrobial therapy, and dietary modifications, may help minimize the adverse effects of orthodontic treatment on oral health.

Keywords: *Dysbiosis, Fixed Orthodontic Appliances, Orthodontic Treatment, Oral Microbiota, Oral Health Outcomes.*

Introduction

Orthodontic therapy plays a central role in correcting malocclusions towards achieving better overall aesthetics, function, and oral health [1, 2]. By using various appliances, orthodontic treatment aims to align teeth, correct bite discrepancies, and enhance facial harmony [3, 4]. Orthodontic techniques have over a hundred years evolved to treat wider types of patients [5]. In the pathway of correcting the malalignment, it is observed that orthodontic therapy can also exert significant effects on the oral microbiome [6].

The oral microbiome consists of a diverse array of bacteria, fungi, viruses, and other microorganisms, which coexist in a symbiotic relationship with the host [7]. This microbial community plays a major role in maintaining oral health by contributing to life processes such as digestion, immune modulation, and defence against pathogens [8]. However, disruptions to this balance, termed dysbiosis, can lead to various oral diseases, including dental caries, periodontal diseases, and oral infections [9].

Orthodontic appliances can create unique microenvironments within the oral cavity that may alter the composition and dynamics of the said oral flora [10]. Factors such as the presence of brackets, wires, and orthodontic attachments can promote plaque accumulation, hinder proper oral hygiene practices, and create niches for microbial colonization [11]. Additionally, changes in oral pH, saliva flow, and mucosal integrity associated with the orthodontic treatment may further drive the microbial

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ecology of the oral cavity towards the pathogenic side [12].

Understanding the impact of orthodontic therapy on oral flora is essential for comprehensive patient care and treatment planning. By elucidating the mechanisms underlying microbial changes during orthodontic treatment, clinicians can develop strategies to mitigate the risk of oral diseases and promote optimal oral health outcomes [13]. This paper aims to explore the current evidence regarding the effects of orthodontic therapy on oral flora composition, microbial dynamics and associated clinical implications. Through a comprehensive review of existing literature, we seek to provide insights into this evolving area of research and highlight avenues for future investigation.

Effects of Orthodontic Appliances on Oral Hygiene Practices

Orthodontic appliances, such as braces, wires, brackets, and aligners, create additional surfaces and niches where food particles and plaque can accumulate [14]. These components can obstruct toothbrush bristles and make it challenging to effectively clean all tooth surfaces. As a result, individuals with orthodontic appliances may find it more difficult to maintain optimal oral hygiene [15]. Plaque accumulation increases the risk of dental caries, gingivitis, and periodontal disease if not adequately removed through proper oral hygiene practices [16]. Prolonged plaque accumulation around orthodontic brackets can result in demineralization of enamel, leading to the formation of white spot lesions [17]. Poor oral hygiene practices in individuals undergoing orthodontic treatment can contribute to gingival inflammation and periodontal disease. Orthodontic appliances may further exacerbate gingival inflammation by impeding access to interdental spaces and gingival margins [18].

Changes in Microbial Diversity during Orthodontic Treatment

Periodontal pathogens are generally grouped into yellow, orange, and red complexes. The yellow complex group includes species like *Streptococcus mitis*, *Streptococcus oralis*, and *Streptococcus sanguinis*. These are early colonizers of the dental biofilm and are generally considered less pathogenic. About orange complex bacteria, they majorly include *Fusobacterium nucleatum*, *Prevotella intermedia*, and *Campylobacter rectus*. They bridge early colonizers with more pathogenic species, called the ecologic succession of bacteria on the tooth surface or dental plaque, contributing to inflammation. The Red complex bacteria are the highly pathogenic ones and include *Porphyromonas gingivalis*, *Tannerella forsythia*, and *Treponema denticola*. They are very strongly associated with advanced periodontal disease and cause significant tissue destruction and bone loss.

The Streptococci [yellow complex] initiates the colonisation sequence of the supragingival plaque. These are gradually replaced by Actinomycetes, and at the bleeding sites and gingival pockets, they attach to the orange and red complexes, which are commonly found in both inflamed and non-inflamed pockets as well as supragingival and subgingival plaques [19].

The Role of Other Microscopic Agents in Gingival and Oral Health Protozoa, fungi, and viruses are noteworthy because they can also cause gingival diseases. For example, *Entamoeba gingivalis*, which causes periodontal destruction, and linear gingival erythema, which is linked to Candida albicans in children with AIDS [20]. The Candida species have been linked to the development of caries due to their synergistic relationship with *S. mutans*, which is often seen in mature plaque, primarily in children. In addition, they have been implicated in several oral and systemic opportunistic infections [21]. Since viruses infect and damage eukaryotic cells, causing lifelong effects and/or recurrences, their presence in the oral microbiota, also known as the "oral virobiome," is typically indicative of potential infections [22]. Herpes Simplex Virus [HSV], Human Cytomegalovirus [CMV], and Epstein-Barr

Virus [EBV], among other viruses frequently detected at the oral sites, were also found to be substantially more prevalent in severe periodontitis than in healthy microbiome [23]. Several authors have documented viral–bacterial links in aggressive periodontitis, including EBV/CMV with *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans*. These viruses are thought to be the cause of local immunosuppression, which may encourage the colonisation and growth of periodontal bacteria beneath the gingiva, thereby indirectly causing periodontopathy [24].

Microbiota Changes in Orthodontic Patients with Fixed Appliances

Pan et al. found significant differences in microbial counts between orthodontic and non-orthodontic subjects, with the case group showing the highest increase three months after appliance placement [25]. Lucchese et al. noted qualitative and quantitative shifts in plaque following orthodontic treatment, with fixed appliances having a more pronounced effect on cariogenic and periodontopathogen bacteria [26]. Guo et al. conducted a meta-analysis focusing on red-complex members, showing a temporary increase in species examined after treatment onset [27]. Sun et al. found distinct microbial communities in orthodontic patients compared to healthy subjects, with greater microbial diversity in the orthodontic group [28]. Naranjo et al. linked changes in clinical parameters with subgingival plaque in orthodontic patients [29].

Studies have shown that metal brackets with elastomeric ligatures can lead to more plaque retention and bleeding compared to steel ligatures. Self-ligating brackets have been associated with higher bleeding and worse plaque index [30]. Various studies have reported an increase in bacteria, mainly *Streptococci* and *Lactobacilli*, with self-ligating brackets. Ireland et al. examined microbial communities in plaque samples from orthodontic patients, showing changes in plaque populations within three months of fixed treatment [31]. Levrini et al. found better control over biofilm formations and less severe periodontal indexes in clear aligner wearers compared to fixed orthodontics wearers [32]. Lombardo et al. reported increased total bacterial load and specific bacteria in the fixed appliances group during treatment [33].

Two meta-analyses confirmed that removable appliance wearers have better periodontal health than fixed orthodontic appliance wearers [34]. Studies have also examined other pathogenic and opportunistic pathogenic microbes in orthodontic patients, with differences in microbial populations based on age and type of appliance. *Candida* species prevalence has been linked to poor oral hygiene in orthodontic patients, with varying findings on the colonization rate of *C. albicans* during treatment [35].

Patients undergoing orthodontic therapy experience changes in the microbial composition of plaque compared to those not undergoing treatment. Removable appliances are linked to lower risks of periodontal issues and caries due to easier oral hygiene maintenance. Clear aligners are recommended for patients at high risk of gingivitis/periodontitis, especially adults [36, 37]. Fixed appliances have higher risks of caries and white spot lesions compared to self-ligating brackets. Microbial shifts occur during orthodontic treatment, with certain bacteria dominating at different stages. After treatment, the bacterial flora tends to return to baseline, but some long-term effects on periodontal health have been reported. The presence of *Candida* and protozoans in the oral cavity during orthodontic treatment requires further study. The virobiome in orthodontic subjects remains largely unexplored, but the potential role of viruses in periodontal damage is speculated based on existing literature. Tables 1 & 2 summarize the changes in oral flora during orthodontic therapy.

Table 1. Changes in oral Flora during Fixed Orthodontic Therapy, Categorized by the Duration of Appliance Placement

Duration of Appliance Placement	**Oral Flora Changes**
Short-term [Up to 3 months]	- Increase in *Streptococcus mutans* - Increase in *Lactobacilli* - Increase in *Candida* spp. - Decrease in *Actinomyces* spp.
Medium-term [3 to 6 months]	- Continued increase in *S. mutans* - Continued increase in *Lactobacilli* - Continued increase in *Candida* spp. - Gradual decrease in *Actinomyces* spp.
Long-term [6 months or more]	- *S. mutans* reaching plateau - *Lactobacilli* stabilizing - *Candida* spp. stabilizing - Further decrease in *Actinomyces* spp. - Possible increase in *Prevotella* spp. - Possible increase in *Fusobacterium* spp.

Table 2. Appliances and Microbial Species

Orthodontic Appliance	Microbial Species Associated
Removable Appliances	
Orthodontic Retainers	*Streptococcus mutans*
Essix Retainers	*Streptococcus sanguinis*
Hawley Retainers	*Candida albicans*
Fixed Appliances	
Metal Brackets	*Streptococcus mutans*
Ceramic Brackets	*Lactobacillus spp.*
Lingual Braces	*Porphyromonas gingivalis*
Palatal Expanders	*Streptococcus sobrinus*
Space Maintainers	*Candida albicans*
Orthodontic Wires	*Aggregatibacter actinomycetemcomitans*
Elastics	*Fusobacterium nucleatum*
TADs [Temporary Anchorage Devices]	*Prevotella intermedia*

Conclusion

Orthodontic patients must receive comprehensive oral hygiene education to mitigate the effects of dysbiosis and prevent oral health complications. Dental professionals should emphasize the importance of proper brushing, flossing, and appliance cleaning techniques to maintain a healthy oral microbiome.

Dentists and orthodontists should develop individualized treatment plans that consider the

patient's oral health status and susceptibility to dysbiosis. Regular monitoring of oral flora changes throughout treatment can inform adjustments to the treatment approach and preventive strategies.

Addressing dysbiosis during orthodontic therapy requires a proactive approach to long-term oral health management. Implementing strategies to restore microbial balance post-treatment and promoting ongoing preventive care are essential for preserving oral health outcomes beyond orthodontic intervention.

In summary, recognizing the clinical implications of altered oral flora during orthodontic therapy is crucial for optimizing patient care, minimizing treatment complications, and promoting long-term oral health and well-being. Effective management strategies should focus on maintaining microbial balance, preventing oral health issues, and empowering patients to take an active role in their oral hygiene regimen.

References

[1]. Gugino, C. F., Dus, I., 1998, Unlocking orthodontic malocclusions: an interplay between form and function. *Seminars in Orthodontics*, 4(4), 246-255.

[2]. Batista, K. B., Thiruvenkatachari, B., Harrison, J. E., O'Brien, K. D., 2018, Orthodontic treatment for prominent upper front teeth (Class II malocclusion) in children and adolescents. *Cochrane Database of Systematic Reviews*, 3(3), CD003452.

[3]. Macey, R., Thiruvenkatachari, B., O'Brien, K., Batista, K. B., 2020, Do malocclusion and orthodontic treatment impact oral health? A systematic review and meta-analysis. *American Journal of Orthodontics and Dentofacial Orthopedics*, 157(6), 738-744.

[4]. Grippaudo, M. M., Quinzi, V., Manai, A., Paolantonio, E. G., Valente, F., La Torre, G., Marzo, G., 2020, Orthodontic treatment need and timing: Assessment of evolutive malocclusion conditions and associated risk factors. *European Journal of Paediatric Dentistry*, 21, 203-208.

[5]. Marra, P., Nucci, L., Abdolreza, J., Perillo, L., Itro, A., Grassia, V., 2020, Odontoma in a young and anxious patient associated with unerupted permanent mandibular cuspid: A case report. *Journal of International Oral Health*, 12, 182.

[6]. Mulimani, P., Popowics, T., 2022, Effect of orthodontic appliances on the oral environment and microbiome. *Frontiers in Dental Medicine*, 3, 924835.

[7]. Soria, S., Angulo-Bejarano, P. I., Sharma, A., 2020, Biofilms: Development and molecular interaction of microbiome in the human oral cavity. New and Future Developments in Microbial *Biotechnology and Bioengineering: Microbial Biofilms*, 61-75.

[8]. Sedghi, L., DiMassa, V., Harrington, A., Lynch, S. V., Kapila, Y. L., 2021, The oral microbiome: Role of key organisms and complex networks in oral health and disease. *Periodontology* 2000, 87(1), 107-131.

[9]. Cugini, C., Ramasubbu, N., Tsiagbe, V. K., Fine, D. H., 2021, Dysbiosis from a microbial and host perspective relative to oral health and disease. *Frontiers in Microbiology*, 12, 617485.

[10]. Fine, D. H., Schreiner, H., 2023, Oral microbial interactions from an ecological perspective: A narrative review. *Frontiers in Oral Health*, 4, 1229118.

[11]. Cornejo Ulloa, P., van der Veen, M. H., Krom, B. P., 2019, Modulation of the oral microbiome by the host to promote ecological balance. *Odontology*, 107, 437-448.

[12]. Kouvelis, G., Papadimitriou, A., Merakou, K., Doulis, I., Karapsias, S., Kloukos, D., 2021, A prospective cohort study assessing the impact of fixed orthodontic appliances on saliva properties and oral microbial flora. *Oral Health & Preventive Dentistry*, 19(1), 67-76.

[13]. Lucchese, A., Bondemark, L., 2021, The influence of orthodontic treatment on oral microbiology. *Biological Mechanisms of Tooth Movement*, 139-158.

[14]. Raghavan, S., Abu Alhaija, E. S., Duggal,

M. S., Narasimhan, S., Al-Maweri, S. A., 2023, White spot lesions, plaque accumulation and salivary caries-associated bacteria in clear aligners compared to fixed orthodontic treatment: A systematic review and meta-analysis. *BMC Oral Health*, 23(1), 599.

[15]. Baumer, C., Schmidtmann, I., Ohlendorf, D., Ferrari Peron, P., Wehrbein, H., Erbe, C., 2023, Orthodontists' instructions for oral hygiene in patients with removable and fixed orthodontic appliances. *International Journal of Dental Hygiene*, 22(2), 329-336.

[16]. Tiwari, A., Jain, R. K., 2020, Comparison of enamel demineralisation scores between passive self-ligation brackets and conventional ligation brackets in patients undergoing orthodontic treatment: A laser fluorescence study. *Journal of Clinical & Diagnostic Research*, 14(11), ZC16-ZC19.

[17]. Lazar, L., Vlasa, A., Beresescu, L., Bud, A., Lazar, A. P., Matei, L., Bud, E., 2023, White spot lesions (WSLs)—post-orthodontic occurrence, management and treatment alternatives: A narrative review. *Journal of Clinical Medicine*, 12(5), 1908.

[18]. Kwon, T. H., Salem, D. M., Levin, L., 2024, Periodontal considerations in orthodontic treatment: A review of the literature and recommended protocols. *Seminars in Orthodontics*, 18 January.

[19]. Haffajee, A. D., Socransky, S. S., Patel, M. R., Song, X., 2008, Microbial complexes in supragingival plaque. *Oral Microbiology and Immunology*, 23(3), 196-205.

[20]. Velegraki, A., Nicolatou, O., Theodoridou, M., Mostrou, G., Legakis, N. J., 2007, Paediatric AIDS-related linear gingival erythema: A form of erythematous candidiasis? *Journal of Oral Pathology and Medicine*, 28, 178-182.

[21]. Paoletti, I., Fusco, A., Grimaldi, E., Perillo, L., Coretti, L., Di Domenico, M., Cozza, V., Lucchese, A., Contaldo, M., Serpico, R., 2013, Assessment of host defence mechanisms induced by Candida species. *International Journal of Immunopathology and Pharmacology*, 26, 663-672.

[22]. Pannone, G., Santoro, A., Carinci, F., Bufo, P., Papagerakis, S. M., Rubini, C., Campisi, G., Giovannelli, L., Contaldo, M., Serpico, R., 2011, Double demonstration of oncogenic high risk human papilloma virus DNA and HPV-E7 protein in oral cancers. *International Journal of Immunopathology and Pharmacology,* 24, 95-101.

[23]. Puletic, M., Popovic, B., Jankovic, S., Brajovic, G., 2020, Detection rates of periodontal bacteria and herpesviruses in different forms of periodontal disease. *Microbiology and Immunology*, 64, 815-824.

[24]. Sharma, S., Tapashetti, R. P., Patil, S. R., Kalra, S. M., Bhat, G. K., Guvva, S., 2015, Revelation of viral-bacterial interrelationship in aggressive periodontitis via polymerase chain reaction: A microbiological study. *Journal of International Oral Health*, 7, 101-107.

[25]. Pan, S., Liu, Y., Si, Y., Zhang, Q., Wang, L., Liu, J., Wang, C., Xiao, S., 2017, Prevalence of fimA genotypes of Porphyromonas gingivalis in adolescent orthodontic patients. *PLoS ONE*, 12, e0188420.

[26]. Lucchese, A., Bondemark, L., Marcolina, M., Manuelli, M., 2018, Changes in oral microbiota due to orthodontic appliances: A systematic review. *Journal of Oral Microbiology*, 10, 1476645.

[27]. Guo, R., Lin, Y., Zheng, Y., Li, W., 2017, The microbial changes in subgingival plaques of orthodontic patients: A systematic review and meta-analysis of clinical trials. *BMC Oral Health*, 17, 1-10.

[28]. Sun, F., Ahmed, A., Wang, L., Dong, M., Niu, W., 2018, Comparison of oral microbiota in orthodontic patients and healthy individuals. *Microbial Pathogenesis*, 123, 473-477.

[29]. Naranjo, A. A., Triviño, M. L., Jaramillo, A., Betancourth, M., Botero, J. E., 2006, Changes in the subgingival microbiota and periodontal parameters before and 3 months after bracket placement. *American Journal of Orthodontics and Dentofacial Orthopedics*, 130, 275.e17.

[30]. Kim, S.-H., Choi, D.-S., Jang, I., Cha, B.-

K., Jost-Brinkmann, P.-G., Song, J.-S., 2012, Microbiologic changes in subgingival plaque before and during the early period of orthodontic treatment. *Angle OrthHere are the remaining references formatted in the requested style.

[31]. Ireland, A. J., Soro, V., Sprague, S. V., Harradine, N. W. T., Day, C., Al-Anezi, S., Jenkinson, H. F., Sherriff, M., Dymock, D., Sandy, J. R., 2013, The effects of different orthodontic appliances upon microbial communities. *Orthodontics & Craniofacial Research*, 17, 115-123.

[32]. Levrini, L., Mangano, A., Montanari, P., Margherini, S., Caprioglio, A., Abbate, G. M., 2015, Periodontal health status in patients treated with the Invisalign® system and fixed orthodontic appliances: A 3-month clinical and microbiological evaluation. *European Journal of Dentistry*, 9, 404-410.

[33]. Lombardo, L., Palone, M., Scapoli, L., Siciliani, G., Carinci, F., 2020, Short-term variation in the subgingival microbiota of two groups of patients treated with clear aligners and vestibular fixed appliances: A prospective study. *Orthodontics & Craniofacial Research*, 24(2), 251-260.

[34]. Lu, H., Tang, H., Zhou, T., Kang, N., 2018, Assessment of the periodontal health status in patients undergoing orthodontic treatment with fixed appliances and Invisalign system. *Medicine*, 97, e0248.

[35]. Muzurovic, S., Babajic, E., Masic, T., Smajic, R., Selmanagic, A., 2012, The relationship between oral hygiene and oral colonization with Candida species. *Medical Archives*, 66, 415-417.

[36]. Jiang, Q., Li, J., Mei, L., Du, J., Levrini, L., Abbate, G. M., Li, H., 2018, Periodontal health during orthodontic treatment with clear aligners and fixed appliances. *Journal of the American Dental Association*, 149, 712-720.

[37]. Flores-Mir, C., 2019, Clear aligner therapy might provide a better oral health environment for orthodontic treatment among patients at increased periodontal risk. *Journal of Evidence-Based Dental Practice*, 19, 198-199.