Microbiological and clinical periodontal effects of fixed appliances in orthodontic patients

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Abstract

Through a careful analysis of the scientific literature, we want to analyze a microbiological and clinical periodontal effects of fixed appliances in orthodontic patients; we were chosen from “PubMed” several publications about microbiological and clinical effects, orthodontic treatment, fixed orthodontic appliances, gingival inflammation. In the scientific literature there are different methods to evaluate scoring plaque in patients with fixed orthodontic appliances¹. During orthodontic therapy, orthodontists occasionally are confronted with gingival hyperplasia and bleeding on probing²-³. Orthodontic attachments accelerate the accumulation of bacterial plaque through difficulties in maintaining adequate oral hygiene; the frequency of T. forsythia, C. rectus, and P. nigrescens significantly increased after placement of orthodontic appliances⁴. Lindel et al’s study test the null hypothesis that stainless steel and ceramic brackets show no differences in biofilm adhesion⁵. Also, studies to be considered show that after 12 months, the fixed buccal orthodontic appliance group continued to have greater mean PI, GI, and PPD, while a trend was noted for higher BANA scores and BOP⁶.

Introduction

Dental plaque is a highly complex organization in a biofilm form and is considered the main causative factor in dental caries and periodontal disease. Orthodontic treatment with fixed appliances is a risk factor for plaque accumulation. Assessment of dental plaque is therefore essential in evaluation of the oral hygiene of individual patients undergoing fixed appliance treatment and in clinical studies measuring plaque¹. Today three-dimensional tooth movements can be provided by fixed orthodontic appliances. The entire periodontium, including osseous and soft tissue components, remodels with orthodontic tooth movement⁷. However, the presence of periodontal inflammation may inhibit remodeling and compromise the outcome of treatment through the loss of periodontal connective tissue attachment⁸. While some studies have shown periodontal changes induced by orthodontic appliances are transient and do not result in permanent attachment loss, other studies suggest up to 10% of past orthodontic patients have greater periodontal connective tissue attachment loss than the general population⁹. In most cases, fixed orthodontic treatment consists of applying brackets made of stainless steel. Because of the increase in even young adolescents’ needs for more esthetic treatment options, the usage of tooth-colored brackets made of ceramics is on the rise⁵. However, orthodontic therapy using fixed appliances induces clinical side effects due to the presence of more plaque-retentive niches and impaired mechanical plaque removal¹⁰. Clinical studies have shown an increase in biofilm formation combined with an ecological change of the microbial profile after bracket insertion¹¹-¹². The shift in amount, composition, metabolic activity, and pathogenicity of the oral microflora can lead to generalized gingival inflammation and incipient carious lesions¹³. The periodontal side effects, apparent in parameters such as pocket probing depths and bleeding on probing, are considered to be generally transient. In contrast, signs of enamel decalcification, such as white spot lesions at the bracket peripheries, are frequently permanent⁶. Fixed buccal orthodontic appliances have been shown to enhance plaque accumulation and adversely affect periodontal tissues, as measured by gingival inflammation and probing pocket depths. Some studies suggest periodontal health improves with removal of fixed buccal orthodontic appliances or with the daily use of dental floss. After placement, the subgingival bacterial profile shifts from gram-positive aerobic species, associated with periodontal health, to gram-negative anaerobic or facultative species, associated with periodontitis⁶. The placement of orthodontic appliances in subjects undergoing orthodontic treatment provokes adverse changes in gingival microflora with the development of gingivitis and consequently periodontitis (Huser et al. 1990, Orru et al. 2005). Several clinical and microbiological studies demonstrate that, in the absence of good oral hygiene, the placement of orthodontic bands in children results in the formation of increased pocket probing depths concomitantly with a quantitative increase and shifts of the microbial composition of the sub-gingival plaque which resembles the plaque usually found in periodontal diseases, where Tannarella forsythia, Porphyromonas gingivalis and Treponema denticola are prevalent (Blandino et al.,
2004; D’Ercole et al., 2006; Haffajee et al., 2006; Huser et al., 1990; Latronico et al., 2007; Socransky et al., 2002; Ximenez-Fuji et al., 2000)15. It is therefore still unclear whether or not these changes in periodontal and microbial parameters will normalize after the end of active orthodontic therapy. In only a few retrospective studies has the periodontal situation of orthodontically treated patients and non-treated controls been compared (Gomes et al., 2007). Prospective studies are needed to further investigate this topic16. The relationship between orthodontic procedures and periodontal status is considered a challenge, especially periodontal health during and after orthodontic treatment18.

Methods

We carried out a careful analysis of the scientific literature about microbiological and clinical periodontal effects of fixed appliances in orthodontic patients. We were chosen from “PubMed” several publications about microbiological and clinical effects, orthodontic treatment, fixed orthodontic appliances, gingival inflammation.

A number of authors have reported pathological changes in the gingiva following the use of orthodontic appliances, but only a few investigations related to the extent, frequency and severity of gingival alterations have been performed. Some longitudinal studies utilizing index systems to classify the degree of gingival inflammation have been made, but these studies are restricted to the initial phases of treatment19. One approach to scoring plaque is planimetric plaque analysis, which expresses the plaque area as a percentage of the tooth surface covered with plaque. However, the most common basis for plaque scoring is the use of a numeric categorical scale (ie, an index). Several such indices have been developed over the years, most notably those advocated by Silness and Löe, O’Leary, and Quigley and Hein, and its modification, the Turesky index. These subjective visual evaluations are generally based on plaque extent and thickness near the gingival margin and coronal extension of plaque. They were designed to reflect the typical pattern of progression of plaque accumulation17.

Al-Anezi et al’s study was confined to articles in the English language. An electronic search using MEDLINE and PubMed was conducted using the following free-text terms: orthodontics, orthodontic (preventive, corrective, and interceptive), orthodontic brackets, dental plaque, and dental plaque index. They reported significant majority of trials involving patients wearing fixed orthodontic appliances18 have used the plaque index originally described by Silness and Löe. This index is a categorical scale. Code 0 is given when there is no plaque accumulation, code 1 when plaque can be removed from the gingival third, code 2 when there is visible plaque, and code 3 when there is a heavy accumulation of plaque. This index has the merits of simplicity and wide usage throughout dentistry. However, with only four categories, it has relatively poor discrimination. It reflects the common pattern of progression of plaque accumulation in the absence of an orthodontic bracket, so it is inherently

Review
less appropriate for the categorization of plaque on bracketed teeth. Lindel et al's study reported detection of biofilm was positive on all brackets after removal from the oral cavity. A total surface of 26.3 ± 0.9 mm² (stainless steel) and 27.2 ± 0.9 mm² (ceramic) per bracket was analyzed. On stainless steel brackets, biofilm formation was observed on 12.5% ± 5.7% (3.3 ± 1.6 mm²) of the total surface and on 5.6% ± 2.4% (1.5 ± 0.6 mm²) on ceramic brackets. The difference between absolute and relative biofilm formation on stainless steel and ceramic was statistically significant. The amount of biofilm was significantly higher on stainless steel brackets than on ceramic brackets for all intraoral locations. The same applies for the different bracket surfaces, apart from the occlusal and gingival surfaces: these values proved to be not significant; in both groups, the lowest values were found on the buccal surfaces. The greatest amount of biofilm was present on mesial and distal surfaces of the stainless steel brackets, and on occlusal and gingival surfaces of the ceramic brackets. Statistical analysis within groups showed significant differences between the bracket surfaces. Sang-Ho Kim et al reported the frequency of subgingival plaque samples positive at T1 was 1.7% for A. actinomycetemcomitans, 7.5% for T. forsythia, 44.2% for C. rectus, 35.8% for E. corrodens, 6.7% for P. gingivalis, 5.0% for P. intermedia, 25.8% for P. nigrescens, and 11.7% for T. denticola; the frequency of C. rectus and P. nigrescens at T2 was 65.0% and 44.2%, respectively, and differences in frequency between T1 and T2 were statistically significant. The frequency of T. forsythia was increased to 25.8% at T3 and to 36.7% at T4, and differences in frequency between T2 and T3 and between T3 and T4 were statistically significant. The frequency of the other species also tended to increase after placement of orthodontic appliances, although it did not reach the level of statistical significance. In the Karkhanechi et al's study an increase in PI was noted in the fixed buccal appliance group over time. At 6 weeks, no difference in PI was noted between the fixed buccal appliance and aligner groups, but by 6 months and 12 months the PI of the fixed buccal appliance group was significantly greater than the aligner group. In contrast, a slight decrease in PI was noted for the aligner group over the 12-month duration of the study. Associated with the increase in PI was an increase in gingival inflammation. Although both groups had similar GI scores at 6 weeks (P < .126), by 6 months (P < .01) and 12 months (P < .01), the aligner group had significantly lower GI scores. The changes in PI and GI were also associated with changes in BOP. Both groups had similar BOP at 6 weeks (P = .645), but by 6 months a trend towards increased differences in BOP (P=.081) was observed in the fixed buccal appliance group that attained statistical significance by 12 months (P < .05). An increase in PPD was recorded for the fixed buccal appliance group at 6 weeks (P = .012), 6 months (P=.021), and 12 months (P=.003)².

Discussion

Al-Anezi et al. reported a study of Williams et al. in which they addressed the shortcomings of the Silness and Löe index for bracketed teeth by modifying it to take into account the pattern of plaque accumulation in orthodontic patients. In this index, the tooth is divided into medial, distal, gingival, and incisal regions in relation to the bracket. Plaque is then scored in each area based on the four codes used in the original Silness and Löe index, and values summed to obtain a total score, which can therefore range between 0 and 16 for each tooth. This index was also used by Clerehugh et al.²⁹ Costa et al.³¹ and Thiencpont et al.³² in studies of patients with fixed orthodontic appliances. This index acknowledges the usual effects of orthodontic appliances on plaque distribution and has much greater categorical discrimination than the Silness and Löe index. These advantages must be viewed as substantial and as justifying discontinuation of the unmodified Silness and Löe index in orthodontic patients. Lo Bue's clinical results showed that all patients showed the presence of dental plaque at the beginning of the study. Clinical examination was repeated 2 (T2), 4 (T3), and 12 weeks (T4) after the application of the orthodontic appliance. The mean plaque index score (PI) at baseline (T1) was 3.1±0.81. After two weeks (T2) PI was significantly increased (3.9±0.80, p=0.016 vs T1 by t test). Surprisingly the PI score progressively decreased. In fact, at T4 the mean PI was significantly lower than baseline (1.90±0.93; p=0.003). A similar trend was observed in the mean gingival index (GI) at the observed sites. At T1 the mean GI was 1.1±0.56, while at T2 and at T3, GI slightly increased (1.6 ±0.38 and 1.4±0.67 respectively). At T4, the GI was, vice versa, markedly and significantly reduced (0.35±0.41) when compared with the previous time point (p=0.012 vs T1; p<0.0001 vs T2 and T3 by t test). In patients who were motivated to oral hygiene, orthodontic therapy with fixed appliances did not cause an increment of dental plaque; on the contrary a marked reduction was observed. As a result of this improved oral hygiene the GI was also significantly improved. For microbiological results the four sub-gingival plaque sites and the
tongue surface were analyzed in each of the ten patients. Microflora changes were observed at different collection time points. At T1 facultative aerobic species such as Streptococcus species, Actinomyces odontolyticus, Actinomyces israelii were the most frequently detected. At T2 and T3 either facultative aerobic species such as Actinobacillus actinomycetemcomitans, Actinomyces viscosus, Capnocytophaga gingivalis, or anaerobic species such as Eikenella corrodens, Fusobacterium nucleatum, Micrococcus micros, Peptostreptococcus anaerobius, Porphyromonas gingivalis, were more frequently detected. Pseudomonas species was also found. Interestingly at T4 Actinomyces species (A. odontolyticus and A. israelii) and Streptococcus species were again the most representative microorganisms in sub-gingival plaque. On the tongue surface at T1 and T4 the microbiological test disclosed both aerobic facultative (Streptococcus species and A. israelii) and anaerobic species (P. gingivalis, F. nucleatum, P. anaerobius). At T2 and T3, facultative aerobic bacteria such as A. odontolyticus, A. meyeri and A. actinomycetemcomitans, were the most representative species together with Pseudomonas species. E. corrodens was almost always present at the different sampling times. C. gingivalis, M. micros, and the different species of Prevotella, found in sub-gingival plaque were absent in the tongue. Van Gastel et al.’s study was carried out because microbial and clinical periodontal data after completion of orthodontic treatment are largely lacking. The evaluation time was set at 3 months post-treatment. Bacterial culturing has been the classic diagnostic method used to study the composition of dental plaque and is still generally used in periodontal research (Lau et al., 2004; Verner et al., 2006). GCF sampling by paper strips may significantly affect subgingival sampling at the same site but this influence will be similar at all sites because the subgingival plaque sampling was always preceded by GCF sampling (Mullally et al., 1994). Collection of the subgingival plaque before GCF sampling was not considered because the traumatizing effect of the paper points could lead to increased GCF flows. A significant decrease in CFU ratio (aerobe/anaerobe) and thus an increase in pathogenicity of the dental plaque was seen between the beginning and end of treatment (Socransky et al., 1991). This alteration in microbial composition has also been described by others (Kloehn and Pfeifer, 1974; Naranjo et al., 2006; van Gastel et al., 2008). The increased supragingival CFU ratio 3 months after debonding did not differ significantly from that at T1. The subgingival CFU that (aerobe/anaerobe) at T3 on the other hand was significantly different from that at T1. The increased pathogenicity of the dental plaque and the concomitant periodontal changes during orthodontic treatment have been described by several authors (Petti et al., 1997; Naranjo et al., 2006; van Gastel et al., 2008). Sallum et al. (2004) reported on the microbial and periodontal changes such as plaque index, gingivitis index, and PPD after bracket removal. Recently, Thornberg et al.’s data (2009) are contrary to the Van Gastel et al.’s microbial results.

Conclusion(s)

Through this careful analysis, it’s proved that the use of removable aligners facilitates oral hygiene. A significantly lower amount of biofilm was found on ceramic brackets than on stainless steel brackets; placement of fixed orthodontic appliances has a significant impact on microbial and clinical periodontal parameters. During orthodontic leveling and alignment, the frequency of Tannerella forsythia, Campylobacter rectus, and Prevotella nigrescens in gingival crevices increase significantly, thereby heightening the risk of periodontitis. The importance of susceptibility to periodontal disease independent of the presence of a wellknown retentive plaque factor, i.e. orthodontic appliances and/or bands.

References

1. “Quantifying plaque during orthodontic treatment: A systematic review”; Saud A. Al-Anazi and Nigel W. T. Harradine; The Angle Orthodontist; Volume 82, Issue 4 (July 2012)
4. “Microbiologic changes in subgingival plaque before and during the early period of orthodontic treatment”; Sang-Ho Kim, Dong-Soon Choi, Insan Jang, Bong-Kuen Cha, Paul-Georg Jost-Brinkmann and Jae-Seok Song; The Angle Orthodontist Volume 82, Issue 2 (March 2012)
5. “Comparative analysis of long-term biofilm formation on metal and ceramic brackets”; Ira Dewi Lindel, Cornelius Elter, Wieland Heuer, Torsten Heidenblut, Meike Stiesch, Rainer Schwestka-Polly, and Anton Phillip Demling; The Angle Orthodontist Volume 81, Issue 5 (September 2011)
6. “Periodontal status of adult patients treated with fixed buccal appliances and removable aligners over one year of active orthodontic therapy”; Marzieh Karkhanichi; Denise Chow; Jennifer Sipkin; David Sherman; Robert J. Boyle; Robert G. Norman; Ronald G. Craig; George J. Cisneros; The Angle Orthodontist; Volume 83, Issue 1 (January 2013)


