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Periodontal conditions in subjects following orthodontic therapy. A preliminary study

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SUMMARY The present study evaluated the periodontal conditions in dental students after appliance removal (mean period 7.16 ± 3.5 years) compared with an untreated control group. Twenty-five subjects in the treated group (16 females and 9 males: 23.0 ± 2.04 years) and 29 in a control group (15 females and 14 males: 23.99 ± 2.46 years) underwent a periodontal examination: visible plaque index (VPI), gingival bleeding index (GBI), bleeding on probing (BOP), periodontal probing depth (PPD), and clinical attachment loss (CAL) of canines, premolars, and banded first molars and unbanded second molars. Statistical analysis was performed using a Mann–Whitney test, a Student's *t*-test, and Tukey's analysis of variance. The level of significance was set at 5 per cent.

The median percentage of positive sites for the treated and control groups for VPI (1.25 ± 2.37 and 1.25 ± 5.45), GBI (0.95 ± 1.81 and 1.23 ± 2.14), and BOP (0.83 ± 6.45 and 0.83 ± 3.43) did not differ between groups. Mean PPD values were 1.33 ± 0.19 and 1.34 ± 0.14 for the treated and 1.40 ± 0.24 and 1.39 ± 0.25 for the control group. No intra- or intergroup differences were observed. For the control group, the smallest PPD was at the canines followed by premolars and molars. PPD was less for premolars than molars but similar to the canines in the treated group. No differences in CAL were observed between the examined teeth in the control group. For the treated group, the canines showed lower CAL values than the first molars. The results indicate that the use of orthodontic appliances is not necessarily related to a worsening of periodontal conditions.

Introduction

The relationship between orthodontic procedures and periodontal status is considered a challenge, especially periodontal health during and after orthodontic treatment.

Several studies have addressed the impact of fixed, removable, and myofunctional orthodontic/orthopaedic appliances or retainers in relation to supragingival plaque accumulation and gingivitis (Dubey *et al.*, 1993; Årtun *et al.*, 1997; Glans *et al.*, 2003; Skold-Larsson *et al.*, 2003). These supragingival conditions are reversible a few months after appliance removal in patients with a good standard of oral hygiene. Alexander (1991) and Atack *et al.* (1996) suggested that orthodontic appliance removal leads to similar periodontal conditions to those observed before treatment.

On the other hand, banded appliances are possible modifying factors in periodontal supporting tissues. It has been advocated that these alterations may directly be related to subgingival location of the bands resulting in destruction of not only the supra-alveolar tissues but also, in some cases, the bone crest. Diedrich *et al.* (2001) observed a high percentage (85 per cent) of band defects in the cervical area associated with histological signs of connective tissue damage and apical migration of the junctional epithelium. Årtun and Urbye (1998) suggested that periodontal support might be also damaged during tooth inclination or intrusion in periodontally diseased subjects.

Several studies have addressed the impact of the presence of orthodontic appliances on cariogenic bacteria (Batoni *et al.*, 2001; Jordan and LeBlanc, 2002; Steinberg and Eyal, 2004). Attention has also been given to the qualitative alterations in the subgingival biofilm, mostly related to destructive periodontal disease (Mattingly *et al.*, 1983; Paolantonio *et al.*, 1999; Sallum *et al.*, 2004) and to the presence of putative periodontopathogens in subgingival areas during orthodontic treatment (Huser *et al.*, 1990; Petti *et al.*, 1997; Perinetti *et al.*, 2004). The occurrence of inflammatory mediators such as interleukins and prostaglandins (Skold-Larsson *et al.*, 2003) and glycosaminoglycan (Pender *et al.*, 1994) has been investigated. A positive increase in clinical signs of subgingival inflammation, i.e. bleeding on probing (BOP) and periodontal probing depth (PPD; Zachrisson and Alnæs, 1973; Alstad and Zachrisson, 1979; Huser *et al.*, 1990), and in crevicular fluid volume (Samuels *et al.*, 1993; Pender *et al.*, 1994) has been observed during fixed orthodontic treatment. However, there is no evidence that microbiological changes (Loomer, 2004), crevicular fluid components (Armitage, 2004a), or clinical inflammatory conditions (i.e. gingivitis, BOP, or PPD) can be implicated in the current condition of the supporting tissues or can predict future clinical attachment loss (CAL; Albandar, 2002).

Measurement of CAL (Fleiss *et al.*, 1990) remains the gold standard to evaluate the destruction of periodontal support associated with fixed orthodontic appliances. Boyd and Baumrind (1992) addressed this problem in banded teeth. However, partial recording of CAL, limited to the bucco-mesial surfaces of upper right and lower left molars, may not reflect the real situation around the teeth, limiting comparison with unbanded molars. The limitations of partial recordings have been highlighted and the importance of a full-mouth examination, six sites per tooth, for a description of periodontal status has been stressed (Kingman and Albandar, 2002; Susin *et al.*, 2005). Thus, if there is agreement that during orthodontic treatment a positive increase of clinical and histological signs of periodontal inflammation might be expected, based on the alteration in subgingival microbiota and inflammation indicators, it is still not clear if these findings permanently influence the susceptibility to periodontal attachment loss in healthy patients undergoing orthodontic treatment.

The aim of the present study was therefore to evaluate periodontal conditions in patients who had undergone orthodontic therapy with fixed appliances, to determine the condition between banded and unbanded molars, and to compare the finding with the periodontal status in a group of untreated subjects.

Subjects and methods

Study population

The present cross-sectional, blind, controlled study was conducted according to the Declaration of Helsinki, and approved by the Committee for Ethical Affairs of the Lutheran University of Brazil.

Fifty-four selected dental students, after written informed consent was obtained, constituted the study population. They were divided into a treated and a control group. Individuals who underwent fixed orthodontic therapy with banded first molars constituted the treated group ($n = 25$, 64 per cent female, mean age 23.00 ± 2.04 years). The control group comprised 29 individuals who had not undergone orthodontic therapy (51.72 per cent female, mean age 23.99 ± 2.46 years). All subjects were healthy, had never smoked, had no history of periodontitis before or during orthodontic therapy, had at least 20 teeth including molars, premolars, and canines without proximal or bucco-lingual restorations, and did not use chemical plaque control agents.

Data collection

Calibration procedures. Calibration was conducted on six non-participants with similar periodontal conditions to the subjects both prior to and during the research. The same examiner (SLV) assessed PPD and CAL, at six sites per tooth, on the selected teeth (molars, premolars, and canines). The examinations were performed with a 1-week interval. Kappa statistics for PPD and CAL was 0.59 and 0.79 before and 0.78 and 0.89, respectively, during the experiment.

Clinical examination. The clinical examinations, performed by one examiner (SLV) blinded to the orthodontic history of the individuals, at six sites per tooth were assessed using the visible plaque index (VPI) and gingival bleeding index (GBI), according to Ainamo and Bay (1975), and PPD, CAL and BOP, according to Armitage (2004b). A manual Williams probe (Neumar, São Paulo, Brazil) was used, except for the VPI.

Data analysis

The median percentage values of sites positive for VPI, GBI, and BOP were calculated for each group and compared using a Mann–Whitney test, and the mean values for PPD and CAL with a Student's *t*-test. Intragroup comparisons between teeth were performed with Tukey's analysis of variance. The level of significance was set at 5 per cent.

Results

Table 1 shows the median percentage of sites positive for VPI, GBI, and BOP. The VPI values were 1.25 for both groups. For the GBI, the treated group showed a median value of 0.95 (±1.81) and the control group 1.23 (±2.14). BOP median values (0.83) were the same for both groups. For all parameters, no statistically significant differences were observed between the groups.

The mean values for PPD are shown in Table 2. For the molars, both groups showed mean values around 1.33–1.40 mm. No significant intra- or intergroup differences were observed (banded versus unbanded molars). However, the premolars and canines differed from the molars in both groups, and in the control group the mean PPD for the canines was statistically different.

Table 3 shows the mean values for CAL. Comparisons between groups did not reveal any significant differences. For the control group, no significant differences were found. However, in the treated group the canines showed the lowest values (0.48 ± 0.17 mm) that were statistically different

Table 1 Median (standard deviation) of the percentage of positive sites assessed using the visible plaque index (VPI), gingival bleeding index (GBI), and bleeding on probing (BOP) in the treated and control groups.

Parameter	Group		P*
	Treated (n=25)	Control (n=29)	
VPI	1.25 (±2.37)	1.25 (±5.45)	0.36
GBI	0.95 (±1.81)	1.23 (±2.14)	0.77
BOP	0.83 (±6.45)	0.83 (±3.43)	0.95

*Mann–Whitney test, α=0.05.

Table 2 Mean values (standard deviation) for periodontal probing depth, in millimeters, in the treated and control groups.

Examined teeth	Treated (n=25)	Control (n=29)	P*
First molar	1.33 (0.19)^{a}	1.40 (0.24)^{a}	0.235
Second molar	1.34 (0.14)^{a}	1.39 (0.25)^{a}	0.439
Premolars	1.24 (0.13)^{b}	1.29 (0.21)^{b}	0.299
Canines	1.19 (0.12)^{b}	1.22 (0.17)^{c}	0.487

*No statistically significant differences were observed between the treated and control groups (Student's t-test, α=0.05). Different letters in the column indicate statistically significant differences (Tukey's analysis of variance, α=0.05). In the treated group, the molars differed from the canines and premolars. In the control group, the molars differed from the premolars and canines. Comparison between the premolars and canines revealed statistically significant differences.

Table 3 Mean values (standard deviation) for clinical attachment loss, in millimeters, in the treated and control groups.

Examined teeth	Treated (n=25)	Control (n=29)	P*
First molar	0.58 (0.25)^{a}	0.58 (0.26)^{a}	0.941
Second molar	0.51 (0.19)^{ab}	0.53 (0.23)^{a}	0.79
Premolars	0.54 (0.21)^{ab}	0.52 (0.2)^{a}	0.706
Canines	0.48 (0.17)^{b}	0.49 (0.2)^{a}	0.881

*No statistically significant differences were observed between the treated and control groups (Student's *t*-test, α=0.05). Different letters in the column indicate statistically significant differences (Tukey's analysis of variance, α=0.05). In the treated group, the first molars differed from the canines. In the control group, no statistically significant difference was observed between teeth.

from the first molars (banded teeth: 0.58 ± 0.25 mm). No other significant differences were observed.

Discussion

The present study compared the periodontal conditions of orthodontically and untreated individuals. The results showed similar periodontal conditions for both groups and suggested an absence of permanent periodontal damage, traditionally related to fixed appliances and to banded molars, at least in non-susceptible subjects.

The study population comprised a sample of dental students. It is generally accepted that this population shows a higher pattern of a supragingival plaque control, thus reducing selection bias and misinterpretations. Only systemically healthy non-smokers were included. Some well-known systemic conditions (e.g. neutropenia, diabetes, medication, etc.) and tobacco exposure may negatively influence the pattern of periodontal conditions (Albandar, 2002; Nunn, 2003).

The findings showed low levels of plaque and gingivitis in both groups, with no intergroup differences. The variables chosen to assess plaque and gingivitis, similar to other studies, were VPI (Di Murro *et al.*, 1992; Skold-Larsson *et al.*, 2003; Perinetti *et al.*, 2004) and GBI (Di Murro *et al.*, 1992; Skold-Larsson *et al.*, 2003). Some authors have reported a positive increase in plaque and gingivitis levels during orthodontic treatment (Alexander, 1991; Boyd and Baumrind, 1992; Skold-Larsson *et al.*, 2003; Sallum *et al.*, 2004) probably due to the plaque retentive conditions related to the appliances (Huser *et al.*, 1990). It is important to note that most studies are performed during or at least a few months after orthodontic appliance removal. In the present study, the mean period after appliance removal was 7.16 ± 3.5 years.

Bleeding on subgingival probing was also evaluated. The results showed a low percentage of sites positive to BOP, with no differences between the groups. Other studies did not evaluate this subgingival inflammatory indicator (Zachrisson and Alnæs, 1973; Alstad and Zachrisson, 1979; Huser *et al.*, 1990). It has been established that marginal and subgingival signs of inflammation are associated with gingivitis and periodontitis (Page *et al.*, 1997). The findings suggest that the presence of fixed appliances with banded molars does not permanently influence inflammation. Thus, it seems that the quantitative and qualitative differences in subgingival microbiota (Mattingly *et al.*, 1983; Huser *et al.*, 1990; Petti *et al.*, 1997; Paolantonio *et al.*, 1999; Sallum *et al.*, 2004; Perinetti *et al.*, 2004) and inflammatory markers (Samuels *et al.*, 1993; Pender *et al.*, 1994; Skold-Larsson *et al.*, 2003) do not result in permanent changes. The majority of reported studies have not described this clinical finding after appliance removal.

In the present study, the mean values for PPD were not different between the groups. Thus, it can be speculated that previous orthodontic appliance wear is not associated with permanent alterations in the subgingival area. The values (varying from 1.19 to 1.40 mm) are lower than those found by Alexander (1991). That author reported mean values of 2.5 mm (pre-treatment), 3.13 and 2.55 mm during treatment for banded and bonded teeth, and 2.4 and 2.6 mm, respectively, 1 month after appliance removal. Boyd and Baumrind (1992) observed 2.50 and 3.31 mm 3 months after the completion of orthodontic treatment. Both values are higher than those in the present study. These results may be related either to the time intervals for evaluation or to the lack of calibration in data collection.

The observed mean CAL in the present study was not different either for banded or for unbanded teeth, or between the groups. Nevertheless, the values for the treated group (0.48 and 0.58 mm for banded molars) are different from those reported by Alstad and Zachrisson (1979) of 0.02 and 0.06 mm, in adolescents.

The present study comprised dental students with a mean age of 23.93 ± 2.46 years. It can be argued that dental students may show higher levels of oral hygiene than otherwise comparable populations. Although one cannot ascertain the eventual influence of this variable, it should be kept in mind that the mean number of years after completion of the orthodontic treatment in the sample was 7.16 ± 3.5 years. This is particularly relevant for CAL measurements that are incremental in nature. The differences between studies, on the other hand, can be explained by the expected CAL related to ageing (Nunn, 2003) or the fact that only the mesio-buccal surfaces of the upper right and lower left molars were examined. Even though index teeth have been used in other clinical investigations (Alstad and Zachrisson, 1979; Huser *et al.*, 1990), there is strong evidence that they are limited in describing the exact condition of the periodontal tissues (Kingman and Albandar, 2002; Susin *et al.*, 2005). The values in the intergroup comparison in the present research are in accordance with those of Zachrisson and Alnæs (1973) and Polson *et al.* (1988).

Within the characteristics and the well-known limitations of cross-sectional studies, it can be speculated that even in subjects where differences in PPD and CAL were observed among the groups of teeth, the clinical impact of the differences might be questioned. Differences between statistical significance and clinical relevance are still a matter of discussion.

Conclusions

The use of orthodontic appliances is not necessarily related to worsening periodontal conditions. The results of the present study reinforce the importance of susceptibility to periodontal disease independent of the presence of a well-known retentive plaque factor, i.e. orthodontic appliances and/or bands.

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