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Recovery of Clinical Periodontal Parameters After Orthodontic Appliance Removal: A Prospective Study

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Abstract

Objectives: Considering the changes in periodontal parameters after orthodontic treatment and lack of adequate evidence on the return of these parameters to normal, the aim of this study was to evaluate the time needed for recovery of periodontal parameters to normal after debonding.

Methods: In this prospective study, 24 patients (21 females and 3 males) with a mean age of 18.86 $\pm$ 4.64 years were included, who were in the final stage of their orthodontic treatment and ready for debonding of orthodontic brackets. The most important inclusion criteria were: No history of periodontal problems, no extensive restorations and caries, no smoking, no systemic disorders and no calculus. In each session, the patients were given oral health instructions and then probing depth (PD), plaque index (PI), gingival index (GI) and bleeding on probing (BOP) of the first molars and central incisors of each quadrant were evaluated at the time of debonding (T1), and one (T2), two (T3) and three (T4) months later; in patients who did not return to normal status (GI $\leq$ 0.5, negative BOP, PD $\leq$ 3 mm) after 3 months, the measurements were repeated in subsequent months (up to 6 months). ANOVA followed by pairwise Tukey comparisons were used for determining differences in PD, GI, BOP and PI between the time intervals.

Results: In general, all the parameters were decreased from T1 to T4. Furthermore, comparisons between different intervals using post hoc Tukey test showed that decreases in PD of the buccal surface and proximal surface in comparison to debonding time were significant during the first and second months, respectively ($P < 0.05$). Interpretation of statistical data showed a significant reduction in GI after two months. BOP became negative and significantly different after one month in half of the teeth and two months in the other teeth. PI generally decreased from T1 to T4.

Conclusions: Based on the results of this study, periodontal parameters returned to normal one to two months after debonding.

Keywords: Orthodontics, Gingival Index, Bleeding on Probing.

1. Background

Esthetics has long been considered as one of the main issues and in almost all the treatments it is one of the main criteria (1). Orthodontic treatment has a great impact on esthetics of the face and smile and can lead to functional occlusion and proportionate dentofacial complex (2).

It has been founded that fixed orthodontic treatment can lead to accumulation and maturation of dental plaque because of retentive surfaces of bands and brackets (3). There may also be an association between orthodontics and progression of gingivitis to periodontitis. For example, orthodontic intrusion may change supragingival plaque to subgingival plaque and convert gingivitis to periodontitis (4).

In addition, direct damage to gingiva because of residual bonding material, high levels of forces and changes in subgingival microbial flora have been found in some studies (5). Increased levels of *Prevotella melaninogenica*, *Prevotella intermedia* and *Actinomyces odontolyticus* and decreased proportion of anaerobic microorganisms in the gingival sulcus after band placement have been reported (6, 7). These changes can be manifested by increased inflammation and probing depth and also increased gingival sulcular fluid during orthodontic treatment (8); therefore, the relationship between orthodontic processes and periodontal health during orthodontic treatment has been considered as an important issue (9).

Although these changes occur in the periodontium during orthodontic treatment, studies that show the per-

manent effect of orthodontic treatment on periodontium are lacking (10). In fact a few short-term retrospective studies have assessed the persistence of these changes (10, 11).

2. Objectives

Therefore in this prospective study, we assessed periodontal conditions of patients undergoing fixed orthodontic treatment, on the day of debonding and 1, 2 and 3 months after debonding and up to 6 months for subjects in which these parameters did not return to normal after 3 months.

3. Methods

For this prospective study, samples were collected from patients receiving treatment in Hamadan Dental Clinic, who were in the final phase of comprehensive orthodontic treatment and were ready for debonding. The inclusion criteria for the participants were as follows: No history of systemic diseases, no smoking, no extensive restorations, plaque index < 20%, no history of periodontal diseases before orthodontic treatment, no history of antibiotic use during and 2 months before the start of the study, no calculus on experimental teeth, no pockets > 5 mm, fixed orthodontic appliances in both arches and oral hygiene instructions before orthodontic commencement.

Before participation in this study, the research plan was completely explained to the patients, and they were assured that the research protocol would have no deleterious effect on their treatment outcomes. Informed consent was obtained, and the study protocol was approved by the Ethics Committee of Hamadan University of Medical Sciences, Iran (IR.umsha.rec.1394.436).

After debonding and before final polishing, probing depth (PD), plaque index (PI), gingival index (GI) and bleeding on probing (BOP) were assessed on the first molars and central incisors of both arches. At the same appointment, oral hygiene instructions were given to the patients. The measurements were repeated 1, 2 and 3 months after debonding and for the patients in which the periodontal condition did not return to normal (GI $\leq$ 0.5, negative BOP, PD $\leq$ 3 mm), after 3 months, measurements were repeated in subsequent months (up to 6 months). All the measurements were made by one investigator (Z.M.).

Williams periodontal probe (Derby Instruments by ASA Dental, made in Italy, DD116-14) was used for assessing probing depth which is the distance from the free gingiva to the depth of the gingival sulcus (5). The probing depth was measured at 4 points around the tooth (mesial, buccal, distal and lingual).

Bleeding on probing (BOP) was measured 15 seconds after the insertion of probe into the gingival sulcus. For probing, a standardized pressure of 25 g was used to eliminate operator bias. The following scores were assigned to each tooth: 0: No bleeding; 1: Bleeding on probing (12).

Gingival index (GI) was also assessed for the teeth. GI suggested by Loe (13) includes the following ranking:

0. Absence of inflammation

1. Mild inflammation: A slight change in color, little change in texture, no bleeding on probing

2. Moderate inflammation: Moderate glazing, redness, edema and hypertrophy, bleeding on probing

3. Severe inflammation: Marked redness, hypertrophy, tendency for spontaneous bleeding, ulceration

GI score for each patient was determined by adding scores of all the teeth and dividing it by number of all the assessed teeth (5).

The O'Leary index was used to determine plaque index (5). The patient was instructed to chew a disclosing agent and after rinsing the mouth, all the tooth surfaces, except for the occlusal surface, were assessed along the dentogingival junction. The plaque index was calculated by dividing the number of colored surfaces by the total surfaces and multiplying by 100. All the measurements were recorded in periodontal charts in every visit.

All the measurements were made by one investigator and also all the patients received oral hygiene instructions by one person after debonding.

3.1. Sample Size Calculation

Considering the measurements of the variables made at 4 different time intervals, repeated-measures statistical techniques were used for the analysis of data. Due to the unavailability of data on the main variable (the probing depth) at the intended time intervals from previous studies and the unfeasibility of the use of a pilot study to achieve a sample size based on repeated measures, it was not possible to use an appropriate formula for the analyses. In addition, since the baseline and final data were available from previous studies and since one of the main aims of the study and also the most important aim was to determine the difference in the main variable between the baseline and the end of the study, sample size technique for paired samples was used. Based on data available from previous studies, the sample size was estimated at 24; however, it was possible to increase the sample size to 30 due to the availability of samples by considering $\alpha = 0.02$, $\beta = 0.05$, d = 2 and $\sigma = 2.2$, using the formula below, with d = the mean difference between the two intervals and σ = standard deviation of differences for the two intervals:

$$\frac{\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2}{d^2}\sigma_d^2 + \frac{Z_{1-\frac{\alpha}{2}}^2}{2} \quad (1)$$

3.2. Statistical Analysis

ANOVA was used to determine differences between the time intervals for PD, GI, BOP and PI. Post hoc Tukey tests were used for pairwise comparisons between time intervals (T0, T1, T2 and T3). Statistical significance was set at $P < 0.05$.

4. Results

Twenty-four patients with a mean age of 18.86 $\pm$ 4.64 years and an age range of 13 - 30 years were selected. One of the patients missed follow-up appointments and was excluded from the study. Finally, 23 patients (20 females and 3 males) were analyzed.

4.1. Probing Depth

In the right maxillary first molars probing depth decreased from T1 to T4. Post hoc Tukey test showed a significant decrease in comparison to the debonding appointment (T0) for distal and buccal surfaces from the first month (T1) and for mesial surface from the second month (T3). On the left side, probing depth also decreased from T1 to T4 and post hoc analysis showed a significant decrease for the buccal surface from the first month and for distal and mesial from the second month. Figure 1 shows comparison of probing depth in maxillary first molars at different time intervals.

In the maxillary right central incisors probing depth decreased from T1 to T4. Post hoc Tukey test showed a significant decrease in mesial probing depth from the first month (T2) and for distal and buccal probing depth from the second month (T3). On the left side, all the surfaces exhibited significant decreases in probing depth from the second month (T3). Figure 2 shows comparison of probing depths in maxillary central incisors at different time intervals.

For mandibular first molars there was a significant decrease from the first month (T2) on the distal and buccal surfaces but from second month (T3) in the mesial aspect. On the left side, the probing depth decreased significantly in the second month (T3) for the distal surface and for the buccal and mesial surfaces in the first month (T2). Figure 3 shows comparison of probing depths in mandibular first molars at different time intervals.

In mandibular central incisors, probing depth decreased from T1 to T4. On the mesial and distal surfaces of the right side a significant decrease occurred from the first month (T2) and on the buccal surface a significant difference was seen from the second month (T3). On the left side, post hoc analysis showed a significant difference in the first month for the distal surface from the second month (T3) in mesial and buccal surfaces. Figure 4 shows comparison of probing depth in mandibular central incisors at different time intervals.

4.2. Gingival Index

Gingival index decreased from T1 to T4. Post hoc Tukey test showed that for all the experimental teeth gingival index decreased significantly ($P < 0.05$) from the second month (T3).

4.3. Bleeding on Probing

Bleeding on probing (Figures 5 and 6) decreased from T1 to T4. Post hoc Tukey test showed that BOP decreased significantly in lower incisors, upper first molars and left upper incisors from the first month (T2) and in the lower first molars and upper right incisors from the second month (T3).

4.4. Plaque Index

According to the results, PI decreased from T1 to T4 (Figure 7).

5. Discussion

The effect of orthodontic treatment on periodontal condition of patients has long been investigated. It is clear that orthodontic treatment can induce changes in periodontal conditions like microbial flora and probing depth, inflammation and hypertrophy of gingiva (14). However, there is still much doubt about permanent effects of orthodontic treatment on the periodontium in previous studies. The results of the present study support the recovery of periodontal parameters 1 to 2 months after treatment. Buccal probing depth returned to normal after 1 month and interproximal probing depth and gingival index recovered after 2 months. BOP of half of the teeth resolved during the first month and the other half after the second month. PI, too, decreased after removal of the appliance; however, it still exhibited higher levels than normal after debonding. This might be explained by changes in the gingival crevicular fluid that can be a reason for accumulation of plaque.

Van Gastel et al. investigated sub- and supra-gingival microbiology, sulcular fluid, BOP and probing depth. In their study T1 was the baseline, T2 at debonding and T3 was 3 months after treatment (15). Their results showed that these periodontal parameters increased from T1 to T2 but decreased from T2 to T3, consistent with our results but in this study, the follow-up period was up to 3 months whereas our follow-up was up to 6 months if periodontal parameters did not return to normal. Also in van Gastel et

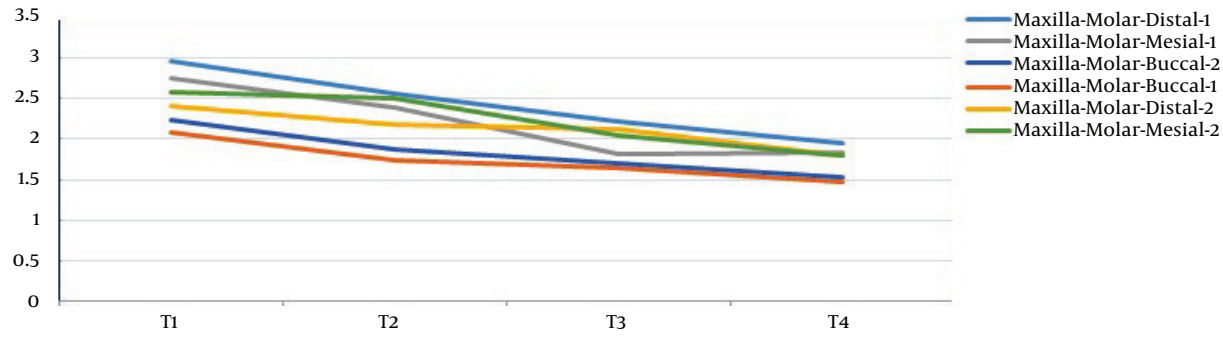

Figure 1. Comparison of probing depths in maxillary first molars at different time intervals

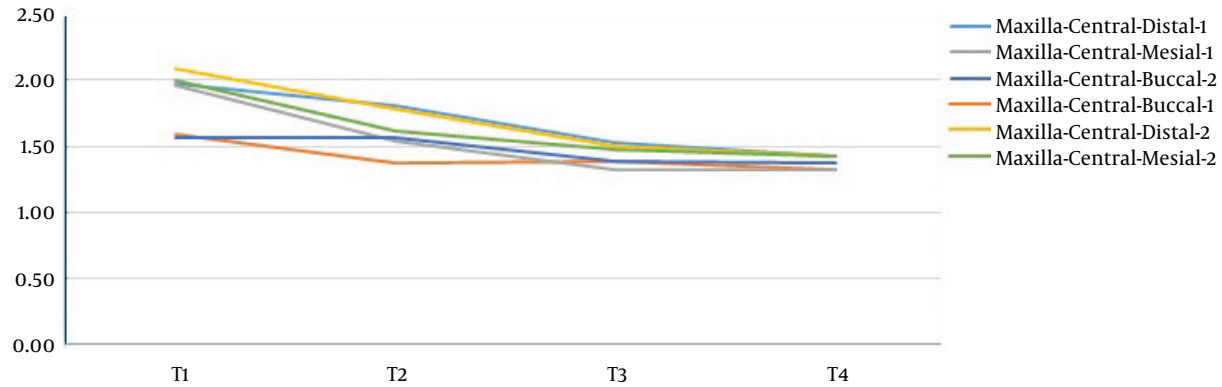

Figure 2. Comparison of probing depths in maxillary central incisors at different time intervals

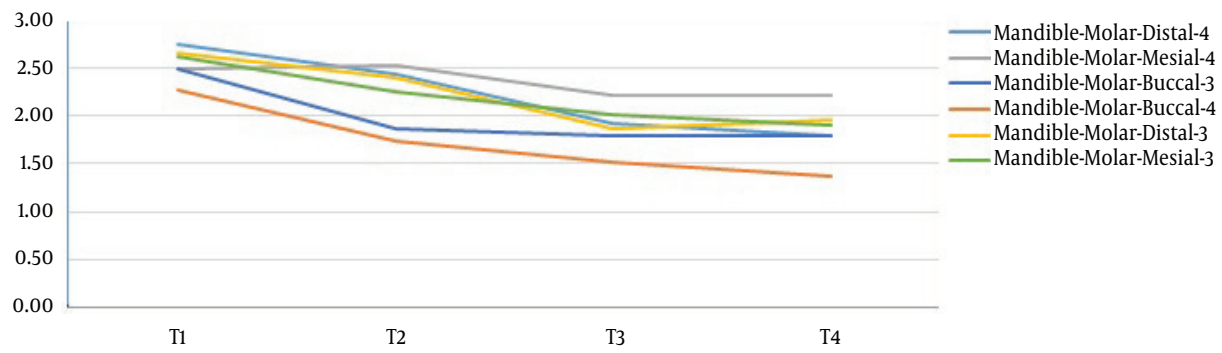

Figure 3. Comparison of probing depths in mandibular first molars at different time intervals

al.'s study no information has been given about the time of full recovery.

In another study by Sallum et al. in 2004, plaque index, gingival index and probing depth were investigated and microbial samples from teeth #26, #11 and #16 were taken at baseline and also after appliance removal (16). In this study, significant decreases in plaque index, gingival index and probing depth were observed, consistent with our results.

In 2014, Ghijselings et al. investigated long-term

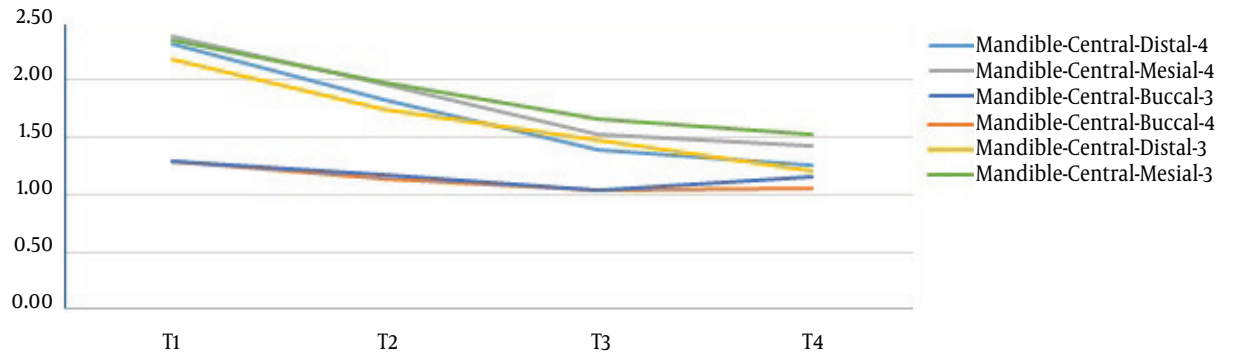

Figure 4. Comparison of probing depths in mandibular central incisors at different time intervals

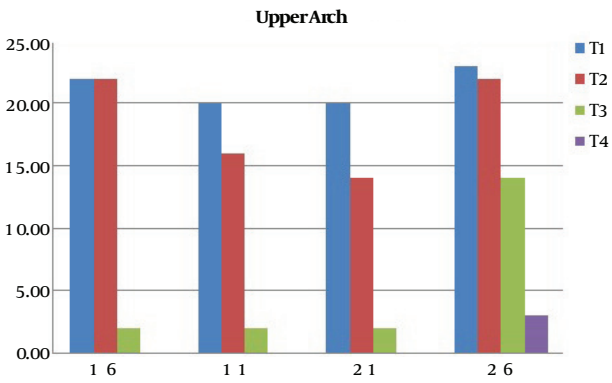

Figure 5. The upper teeth with positive BOP at different time intervals

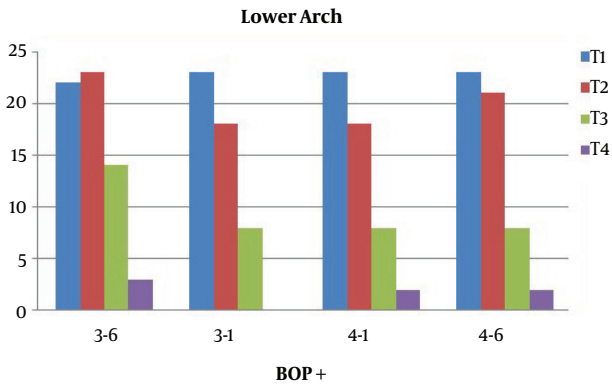

Figure 6. The lower teeth with positive BOP at different time intervals

changes in microbiology and clinical periodontal variations after orthodontic treatment. They assessed microbiology, probing depth, bleeding on probing and sulcular fluid flow at baseline (T1), after debonding (T2) and 2 years after treatment. They concluded that orthodontic treatment increases bacterial load and gingival inflammation. A 2-years follow-up showed that gingiva returned to pretreatment status. These results are consistent with the present study although its third follow-up is much longer (8).

Polson et al. investigated long-term periodontal conditions after orthodontic treatment 10 years after orthodontic treatment in 1988 (3). They concluded that orthodontic treatment in adults has no effect on periodontal health in future but this study was retrospective and the short-term effects of orthodontic treatment were not shown. On the other hand, oral health of patients after 10 years might be different and other factors may play a role, too.

Bollen investigated the effects of orthodontic treatment on periodontal health in a systematic review (10). Because of lack of evidence, they were unable to report any decisive conclusions. The articles did not have favorable follow-up periods, sampling and proper comparison between the groups.

Also Henderson (17) reported that banding might have different effects on the periodontium compared to bonding. It is possible that trauma to gingiva because of debonding could be mistaken for gingival inflammation; therefore, we suggest that future studies include a control group for comparison of periodontal parameters. In addition, it is suggested that more teeth as samples and more parameters like periodontal microbiology and sulcular fluid be checked. It is also better to match the samples in terms of the retainer type that is used after debonding because fixed retainers, for example, have been criticized for their potential to compromise the periodontal status, due to accumulation of plaque and calculus along the retainer because oral hygiene maintenance is difficult with them for patients (18).

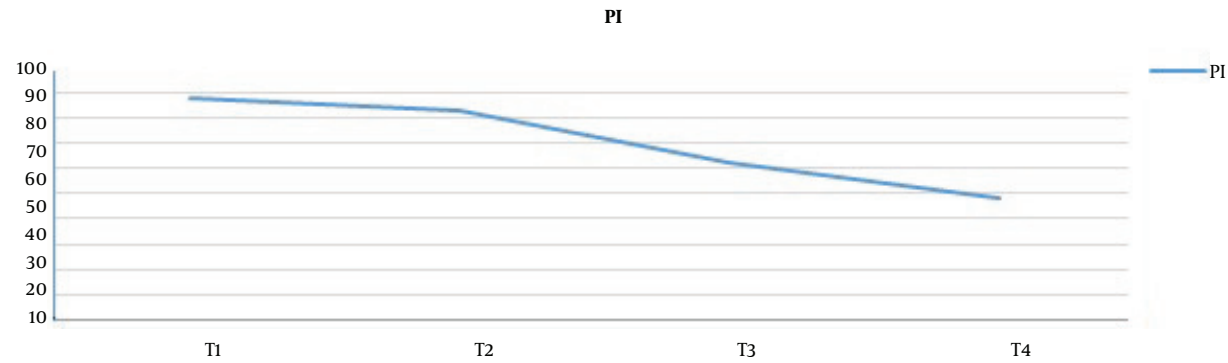

Figure 7. PI changes at different time intervals

5.1. Conclusions

1. Buccal probing depth returned to < 3 mm in the first month and interproximal depth in the second month.

2. The mean gingival index was 0.5 after 2 months.

3. Bleeding on probing in half of the teeth was negative after the first month and in other half in the second month.

Footnotes

Authors' Contribution: Sara Soheilifar: Study concept and design, study supervision; Sanaz Soheilfar: Study concept and design, study supervision; Milad Malekshoar: Statistical analysis, drafting of the manuscript; Bahareh Javanshir: Drafting of the manuscript, critical revision of the manuscript for important intellectual content; Zeinab Mohamadi: Acquisition of data , analysis and interpretation of data.

Conflict of Interests: The authors declare that they have no conflict of interests.

Ethical Considerations: Informed consent was obtained, and the study protocol was approved by the Ethics Committee of Hamadan University of Medical Sciences, Iran (IR.umsha.rec.1394.436).

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