Original Article

Published on 09-04-08

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To cite this article:
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How Do The Periodontal Tissues React During The Orthodontic Alignment and Leveling Phase? Virtual Journal of Orthodontics [serial online] 2008 April 09; 8 (1):p. 1-7
Available from URL http:/www.vjo.it/read.php?file=perio.pdf

Virtual Journal of Orthodontics

# How Do The Periodontal Tissues React During The Orthodontic Alignment and Leveling Phase?

Abstract:

*Introduction: orthodontic tooth alignment and leveling are - usually - the first two stages when an orthodontic treatment is to be initiated. The process of alignment is accomplished by uncontrolled tipping of teeth into a smooth arch and the process of leveling is accomplished by intrusion or extrusion of the teeth so that the upper and lower teeth come together. The aim of this study was to find out whether the orthodontic tooth alignment and leveling phase has negative effects on the periodontal tissues.*
*Subjects and Methods: 10 patients having simple to moderate front teeth crowding were recruited in the study with a total of 120 teeth (10 groups of upper and 10 groups of lower front teeth). The frontal crowded teeth were subjected to a conventional orthodontic alignment and leveling movements by means of a round 16 NiTi wire for the first step and gradually into a rectangular 18 NiTi wire for the second step. The status of the periodontal tissues around the examined teeth was determined by clinical periodontal assessments including Plaque Index (PI), Papillary Bleeding Index (PBI), Probing Depth (PD) and Gingival Index (GI). After 6 months, the orthodontic tooth alignment and leveling phase was completed.*
*Results: in the upper jaw, the Plaque Index increased significantly after 6 months at the buccal, mesial and distal sites of the teeth. The probing depth also increased significantly after 6 months at the buccal site. In the lower jaw, the Plaque Index increased significantly after 6 months at the vestibular, mesial and distal sites. The probing depth also increased significantly after 1, 3 and 6 months at the lingual sites and after 1 and 6 months at the mesial sites. The Gingival Index showed an increase after 6 months only at the distal sites. All the periodontal parameters have been shown to be normal, reflecting a healthy status of the periodontal tissues.*
*Conclusions: during the orthodontic tooth alignment and leveling phase, no considerable negative effects on the periodontal tissues could be noted. The good oral hygiene of the patients during the period of study played an important role in keeping the periodontal parameters within normal limits. Further histological studies are needed to examine the tissue alterations during different phases of the orthodontic treatment.*

Introduction:
Teeth crowding occurs in the mouth when the jaws do not have enough space to hold all of the teeth in a smooth curve. Crowding results in teeth that are stacked on top of each other so that all of the teeth fit in the mouth.
A strong relationship between the abnormal positions of the teeth in the dental arch and the periodontal disorders was previously established (1, 2)
Moreover, it was shown that the number of periodontal pathogens in the anterior sites of crowded teeth is much greater than that in the sites of aligned teeth (3). The correction of the crowded teeth can eliminate any harmful occlusal interference which may offer a great opportunity for the development of a periodontal breakdown (4).
Orthodontic alignment and leveling are – usually - the first two stages when an orthodontic treatment is to be initiated.
The goal of alignment in orthodontic treatment is to correct crowding by lining up all of the teeth into a smooth curve. The process of alignment is accomplished by uncontrolled tipping of teeth into a smooth arch.
Orthodontic leveling is a method used to align the upper teeth properly with the lower teeth. The process of leveling is accomplished by intrusion or extrusion of the teeth so that the upper and lower teeth come together.

Many past studies mentioned that several types of gingivitis, periodontitis, gingival recession and the formation of gingival pockets had been noted during and / or after an orthodontic treatment (5-8).
Most gingival recessions which occur during an orthodontic treatment had been shown in the regions of the anterior upper and lower teeth (9-12). Steiner and colleagues (13) mentioned that the gingival recessions noted after an orthodontic treatment tend to occur in the regions were the keratinized gingiva and the underlying bone tissues are thin.
Moreover, during any orthodontic treatment, a slight to moderate degree of gingival overgrowth might be seen (14-16).
To our knowledge, there has been -to date- no study that discusses the relationship between orthodontic alignment and leveling movements and the periodontal tissues' reaction around the teeth involved in the orthodontic treatment.
The aim of this study was to examine the effect of the orthodontic tooth alignment and leveling phase on the periodontal tissues.

**Methods:**

Study Population
Ten adult orthodontic patients from the department of orthodontics, faculty of Dental medicine - Damascus University (9 females and 1 male, mean age of 24±6 years) who had different types of Angle classification and teeth position abnormalities were selected to participate in this study.
To be eligible for the study, those patients had to meet the following criteria: (1) good general health; (2) lack of antibiotic therapy during the previous 6 months; (3) absence of anti-inflammatory drug administration in the month preceding the study; (4) periodontally healthy with generalized probing depths ≤ 3 mm and no radiographic evidence of periodontal bone loss; and (5) requirement of an orthodontic treatment plan starting with alignment and leveling as a first stage. One week before the baseline examination, all patients underwent a session of supra – and subgingival ultrasonic scaling and were given written and oral hygiene instructions to be maintained during the whole period of the study.

**Experimental Design and Clinical Monitoring**

Full orthodontic treatment plans for the selected patients were carefully prepared according to every case separately.
In all of those treatment plans, the first two stages were always an initiation of alignment and leveling of the teeth. It was recommended to include in this study only the patients with simple to moderate frontal teeth crowding, with the ability to correct this crowding in 6 months maximally.
The sample of the study consisted of 120 frontal teeth; 10 groups of upper and 10 groups of lower front teeth. Every group of teeth contained the six frontal teeth from the right canine to the left canine with the canines themselves included. That means every group of teeth (whether upper or lower) contained: the canines, the lateral incisors and the central incisors (table 1).
In every patient and after proper extraction of the first premolars, the frontal crowded teeth were subjected to a conventional orthodontic alignment and leveling movements by means of a round 16 NiTi wire for the first step and gradually into a rectangular 18 NiTi wire for the second step. All important modifications were made according to every case separately.
The status of the periodontal tissues around the examined teeth was determined by clinical periodontal assessments, including Plaque Index (PI) (17), Papillary Bleeding Index (PBI) (18), Probing Depth (PD) and Gingival Index (GI) (19).
The plaque index assesses only the thickness of the plaque at the gingival area of the tooth. It examines the following scoring units of the teeth: distofacial, facial, mesiofacial and lingual surfaces. A mouth mirror and a dental explorer are used after air drying of the teeth to assess plaque, and the PI score for each area is obtained by totaling the four plaque scores per tooth. The criteria for the (PI) are as follows:

0 = No plaque in the gingival area.
1 = A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may be recognized only by running a probe across the tooth surface.
2 = Moderate accumulation of soft deposits within the gingival pocket and on the gingival margin and / or adjacent tooth surface that can be seen by the naked eye.
3 = Abundance of soft matter within the gingival pocket and / or the gingival margin and adjacent tooth surface.
The papillary bleeding index assesses the sulcus bleeding on probing at the interdental papilla.

| | | | |
|---|---|---|---|
| **Number of patients** | | 10 | |
| **Age (Mean ± SD)** | | 6± 24 | |
| **Sex** | **Female** | 9 | |
| | **Male** | 1 | |
| **Sample of study** | | 120 teeth | 10 groups of upper incisors (canines + lateral incisors + central incisors) |
| | | | 10 groups of lower incisors (canines + lateral incisors + central incisors) |

**Table (1): Study population**

| Site | Index | Baseline | 1 Month | 3 Months | 6 Months | ANOVA Test |
|---|---|---|---|---|---|---|
| **Buccal** | **PI** | 0.01± 0.03162 | 0.1± 0.31622 | 0.31± 0.47714 | 0.48± 0.48027* | (P=0.05)* |
| | **PD** | 1.37 ± 0.44981 | 1.19 ± 0.28848 | 1.52 ± 0.63561 | 1.83 ± 0.55387* | (P=0.01)* |
| | **GI** | 0.12 ± 0.22997 | 0.13 ± 0.28303 | 0.26 ± 0.63979 | 0.4 ± 0.69920 | NS |
| **Palatinal** | **PI** | 0 | 0.1 ± 0.31622 | 0 | 0.1 ± 0.31622 | NS |
| | **PD** | 1.45 ± 0.49944 | 1.28 ± 0.47093 | 1.26 ± 0.38064 | 1.31 ± 0.34464 | NS |
| | **GI** | 0 | 0 | 0 | 0 | NS |
| **Mesial** | **PI** | 0.01 ± 0.03162 | 0.1 ± 0.31622 | 0.11 ± 0.31428 | 0.46 ± 0.47888* | (P=0.05)* |
| | **PD** | 1.78 ± 0.63735 | 1.53 ± 0.75872 | 1.71 ± 0.61904 | 2.16 ± 0.67032 | NS |
| | **GI** | 0.16 ± 0.33399 | 0.2 ± 0.34318 | 0.53 ± 0.83539 | 0.4 ± 0.69920 | NS |
| **Distal** | **PI** | 0.01 ± 0.03162 | 0.1 ± 0.31622 | 0.21 ± 0.41753 | 0.51 ± 0.45080* | (P=0.05)* |
| | **PD** | 1.79 ± 0.51305 | 1.56 ± 0.79610 | 1.83 ± 0.72426 | 2.12 ± 0.52662 | NS |
| | **GI** | 0.18 ± 0.34254 | 0.15 ± 0.23214 | 0.46 ± 0.71987 | 0.4 ± 0.69920 | NS |

**Table (2): The plaque index, probing depth and gingival index values in the upper jaw on four surfaces**

Results of pairwise comparisons over the time points within each group:

***** (Baseline) versus (6 months)

| Site | Index | Baseline | 1 Month | 3 Months | 6 Months | ANOVA Test |
|---|---|---|---|---|---|---|
| **Vestibular** | **PI** | 0.03 ± 0.09486 | 0.23 ± 0.49001 | 0.2 ± 0.42163 | 0.8 ± 0.63245* | (P=0.05)* |
| | **PD** | 1.3 ± 0.36514 | 1.22 ± 0.32591 | 1.27 ± 0.29078 | 1.45 ± 0.3865 | NS |
| | **GI** | 0.26 ± 0.43256 | 0 ± 0 | 0.32 ± 0.43410 | 0.5 ± 0.52704 | NS |
| **Lingual** | **PI** | 0 | 0.1 ± 0.31622 | 0.1 ± 0.31622 | 0 | NS |
| | **PD** | 1.46 ± 0.46236 | 1.13 ± 0.3093† | 1.01 ± 0.03162‡ | 1.05 ± 0.05270* | (P=0.05) †‡* |
| | **GI** | 0.1 ± 0.31622 | 0 | 0 | 0 | NS |
| **Mesial** | **PI** | 0.05 ± 0.15811 | 0.2 ± 0.63245 | 0.3 ± 0.48304 | 0.81 ± 0.42804* | (P=0.05)* |
| | **PD** | 2.16 ± 0.70899 | 1.62 ± 0.53499† | 2.05 ± 0.46487 | 2.34 ± 0.50596* | (P=0.05)* † |
| | **GI** | 0.27 ± 0.38887 | 0.16 ± 0.33399 | 0.64 ± 0.65861 | 0.71 ± 0.46773* | (P=0.05)* |
| **Distal** | **PI** | 0.05 ± 0.15811 | 0.2 ± 0.63245 | 0.3 ± 0.48304 | 0.78 ± 0.41579* | (P=0.05)* |
| | **PD** | 2.14 ± 0.69634 | 1.8 ± 0.68960 | 1.98 ± 0.56921 | 2.29 ± 0.61364 | NS |
| | **GI** | 0.22 ± 0.37058 | 0.12 ± 0.22997 | 0.55 ± 0.51478 | 0.61 ± 0.50431* | (P=0.05)* |

**Table (3): The plaque index, probing depth and gingival index values in the lower jaw on four surfaces**

Results of pairwise comparisons over the time points within each group:

***** (Baseline) versus (6 months)

† (Baseline) versus (1 month)

‡ (Baseline) versus (3 months)

| Time<br>Jaw | Baseline | 1 Month | 3 Months | 6 Months | ANOVA Test |
|---|---|---|---|---|---|
| **The upper jaw** | 0.3±0.35590 | 0.2±0.32659 | 0.36±0.63805 | 0.14±0.26749 | NS |
| **The lower jaw** | 0.25±0.33082 | 0.16±0.30983 | 0.4±0.62538 | 0.14±0.21187 | NS |

**Table (4): Papillary bleeding index values in the upper and lower jaws**

NS: no statistically significant difference of pairwise comparisons over the two time points within each group

This index used a scale of 0 to 4 as follows:
0 = No bleeding.
1 = Isolated dots or thin line less than half of the area probed.
2 = Thin line more than one half of probed area or a discrete speck of blood interdentally.
3 = Interdental triangle filled with blood. Blood flows slowly.
4 = Profuse bleeding immediately on probing. Interdental triangle filled.
However, this index was measured and expressed as an overall record for all the teeth in the upper and lower jaws separately.
The probing depth is the distance to which an instrument (probe) penetrates into the pocket.
In our study, the periodontal pocket depth was measured with a millimeter-calibrated periodontal probe (Michigan O probe with Williams markings) on the following scoring units of the teeth: distofacial, facial, mesiofacial and lingual surfaces. The probe was inserted with a firm, gentle pressure to the bottom of the pocket. The shank should be aligned with the long axis of the tooth surface to be probed.
The Gingival Index assesses the severity of gingivitis and its location in four possible areas: the distofacial papilla, the facial margin, the mesiofacial papilla and the entire lingual gingival margin.
Each of the four gingival units is assessed according to the following criteria:
0 = Normal gingiva.
1 = mild inflammation, slight color change, slight edema: no bleeding on palpation.
2 = moderate inflammation, redness, edema and glazing: bleeding on probing.
3 = severe inflammation, marked redness, edema, ulceration: spontaneous bleeding.
Those clinical parameters were assessed as follows: at baseline (prior to orthodontic appliance placement), after 1 month, after 3 months and after 6 months.
After 6 months, the orthodontic alignment and leveling phase was completed.
All the orthodontic procedures and the clinical assessments of the periodontal tissues were done at the department of Orthodontics – Faculty of Dental Medicine - Damascus University.

**Statistics**
The values were calculated as the mean ± standard deviation (SD) and Analysis Of Variance (ANOVA), a calculation procedure to allocate the amount of variation in a process and determine if it is significant or is caused by random noise, was used to evaluate the statistical significance of the differences of the clinical measurements among the experimental categories in each group/column.
A probability of $P \leq 0.05$ was accepted for rejection of the null hypothesis and to state that with a 95% level of confidence that the two parameters are not the same.
All the statistical analyses were done by means of a computer software program (SPSS®-2006).

**Results:**
The upper jaw:
1- The buccal sides
Table (2) shows the plaque index values as recorded at the buccal sites of the teeth. After 6 months, the plaque index increased significantly (0.48) compared to the baseline record (0.01) (P=0.05). The probing depth after 6 months (1.83mm) was also significantly greater than the record at baseline (1.37mm) for (P=0.01).
However, the gingival index and the papillary bleeding index did not show any significant alterations during the whole period of observation tables (2) and (4).
2- The palatinal sites
As it was shown in table (2) no statistically significant differences could be detected on the palatinal sites concerning all the periodontal indices.
3- The mesial sites
The plaque index increased significantly when comparing the baseline record (0.01) to the record after 6 months (0.46) (P=0.05) (table 2). The other periodontal indices did not show any significant differences.
4- The distal sites
Similarly to the results obtained from the mesial sites, only the plaque index increased significantly when comparing the baseline record (0.01) to the record after 6 months (0.51) (P=0.05) (table 2). Whereas, the other indices did not show any significant differences.

The lower jaw:
1- The buccal sides
Only the plaque index values increased significantly from (0.03), at baseline, to (0.8) after 6 months (P=0.05).
2- The lingual sites
The probing depth values were surprisingly decreased from (1.46mm) at baseline to (1.13mm), (1.01mm) and (1.05mm) after 1, 3 and after 6 months respectively at the lingual sites (P=0.05) (table 3). However, the other indices did not show any significant alterations during the whole period of observation tables.
3- The mesial sites
A statistically significant increase of the plaque index was registered on the mesial sites from (0.05), at baseline, to (0.81) after 6 months (P=0.05) (table 3).

The probing depth values were significantly decreased from (2.16mm) at baseline to (1.62mm) after 1 month, and then increased significantly to (2.34mm) after 6 months (P=0.05) (table 3). The gingival index also increased significantly from (0.27) at baseline to (0.71) after 6 months (P=0.05) as it is demonstrated in table (3).

4- The distal sites

The plaque index increased significantly when comparing the baseline record (0.05) to the record after 6 months (0.78) (P=0.05). It was also shown that the gingival index also increased significantly from (0.22) at baseline to (0.61) after 6 months (P=0.05) as it is demonstrated in table (3). However, the other indices did not show any significant differences.

Discussion:

While the orthodontic treatment might contain several types of tooth movements, it is a little bit difficult to expect an exact reaction of the periodontal tissues around the teeth which undergo orthodontic forces.

Many past studies mentioned that several types of gingivitis, periodontitis, gingival recession and the formation of gingival pockets had been noted during and / or after the orthodontic treatment (5-8).If teeth that have thin tissue are going to be moved lingually, there is a potential for the tissue to move coronally and become thicker (20).

An expected relationship could be established between (Tipping) orthodontic movements and gingival recession (21, 22). However, the results of the studies which mentioned the latest idea were remained controversial in concept. In a study of Batenhorst (21), gingival recessions and bone dehiscences after orthodontic tipping of the lower incisors in monkeys had been recorded. In two other studies (23, 24), no real gingival recessions were registered after orthodontic tipping of lower incisors. Moreover, no relationship between the degrees of tipping (proclination) and the gingival recessions were noted. However, other studies did not find any mucco-gingival defects after the orthodontic tipping of the incisors (20).

The challenge of (alignment and leveling), as the first two stages in almost every orthodontic treatment, is to make the upper and lower teeth fit together. While alignment allows aligning the teeth in a virtual smooth curve, leveling continues the process by lining-up the teeth to be at the same level so they can fit against each other.

In our study, it has been focused on the alterations of the periodontal parameters around 120 teeth underwent orthodontic alignment and leveling movements.

It was shown that the values of the plaque index increased significantly on the vestibular/buccal, mesial and distal sites in both the upper and the lower jaw (P=0.05). This increase reflects and assures the ability of the fixed orthodontic elements to attract the dental plaque which is the most powerful initiating factor for periodontal diseases. Those results agree with those obtained from other studies (16).

An increase of the plaque index on the lingual/ palatinal sites was also detected after 1 and 6 months in the upper jaw, and after 1 and 3 months in the lower jaw. However, this increase was not statistically significant and was considered to be negligible but might be explained by the minimal accumulation of dental plaque on those surfaces according to the cleaning action which is normally achieved by the tongue.

It could be stated that the records of the plaque index has been shown to be ranged within accepted limits (0.51 in the upper jaw and 0.81 in the lower jaw) because of the repeated oral hygiene instructions which were given to the patients during the whole period of study.

In clinically healthy gingiva in humans, a sulcus of some depth can be found. The depth of this sulcus, as determined in histologic sections, has been reported as 1.8 mm (25). Other studies have reported depths of 1.5 mm (26) and 0.69 mm (27). The periodontal pocket is a soft tissue change. Radiographs indicate areas of bone loss where pockets may be suspected (28). Zachrisson et al. (15) reported an increase in the probing depth and a slight loss of attachment around the teeth of patients underwent orthodontic treatment with fixed orthodontic.

In our study, the maximal record of probing depth was 2.34 mm after 6 months (lower jaw – mesial sites). However, this record is considered to be normal and does not reflect any destructive disease that may affect the periodontal tissues.

The gingival index (GI) provides an assessment of gingival inflammatory status that can be used in practice to compare gingival health during different phases of periodontal treatment (28). It has been shown that the maximal record of gingival index in the current study was 0.53 in the upper jaw at the mesial sites but without any increase of probing depth. However, no gingival inflammation was detected on the lingual and palatinal sites as those surfaces were almost plaque-free areas during the whole period of the study.

In the lower jaw, the gingival index increased significantly on the mesial and the distal sites. This could be explained by the accumulation of the dental plaque on those surfaces and, consequently, by the raising difficulty for the patients to maintain those areas free of plaque.

The papillary bleeding index is an objective, easily reproducible assessment of the gingival status. It is extremely useful for detecting early inflammatory changes and the presence of inflammatory lesions located at the base of the periodontal pocket (28).

The alterations of the papillary bleeding index in our study were not of statistical significance neither in the upper jaw nor in the lower jaw. It could be stated that more compliance of the patients with the oral hygiene instructions during the study has led to less symptoms of any periodontal tissue destruction, of which bleeding after probing from the papillary areas might be one.

In conclusion, it was clearly shown that, during the orthodontic alignment and leveling phases, no negative effects on the periodontal tissues were noted, the gingiva was in a relative stable situation, no remarkable recessions or bone dehiscences were reported.

As long as the patient's oral hygiene is maintained in high levels, the negative effects of the orthodontic treatments could be avoided.

Further histological studies are still needed in order to uncover the exact tissue alterations that take place during different phases of the orthodontic treatment.

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