

Relationship between orthodontic treatment and gingival health: A retrospective study

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ABSTRACT

Objective: The aim of this retrospective study was to evaluate the relationship between orthodontic treatment and gingival health. **Materials and Methods:** A total of 251 patients among whom 177 were girls and 74 were boys, recruited from the records pool of the Department of Orthodontics, Faculty of Dentistry, University of Gazi, were included in the study. Patients' treatments have been completed by postgraduate students during the period between 2006 and 2012. Patients' folders were analyzed according to their age, treatment time, and the type of orthodontic treatment. Intra-oral photographs were analyzed, and the presence or absence of visible plaque, visible inflammation, and gingival recession were recorded, and incisor inclinations analyzed on lateral cephalometric films, before and after orthodontic treatment. **Results:** No statistically significant difference was found in patients treated with functional appliances before and after treatment. In patients treated with fixed orthodontic appliances, visible plaque, visible inflammation, and gingival recession showed significant increases after treatment, gingival biotype did not show any significant difference. Positive correlation was found between lower incisor position and gingival recession in patients treated with fixed appliance and extraction. And also cuspids were the teeth with the highest prevalence of gingival recession. **Conclusion:** Considering the relationship between orthodontic treatment and gingival health, cooperation among patients, orthodontists, and periodontists is important.

Key words: Gingival health, gingival recession, incisor inclination, orthodontic tooth movement, orthodontic treatment

INTRODUCTION

Periodontic-orthodontic interrelationship has been subject to a lot of investigation until today, and it is a still controversial issue. Malocclusion has been shown to affect periodontal health^[1] and one of the objectives of orthodontic treatment is to promote better dental health and prolong the life of dentition. Orthodontic treatment contributes to better oral hygiene by correcting dental irregularities and reduces (or eliminates) occlusal trauma. Due to these reasons, it has been suggested that orthodontic treatment leads to an improved periodontal status. It seems reasonable that straighter teeth are easier to clean, and perhaps

having all teeth centered in the alveolar housing and occluding correctly may promote a healthier periodontium.^[2]

Although, orthodontic treatment improves dental and skeletal problems, placement of an orthodontic appliance in a patient's mouth is often associated with alterations in the oral hygiene habits and periodontal health. Orthodontic appliances, as well as mechanical procedures, are prone to evoke local soft tissue responses in the gingiva. The proximity of orthodontic appliances to the gingival sulcus, plaque accumulation, and the impediments they pose to oral hygiene habits further complicate the process of efficient salutary orthodontic care.^[3-5]

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The effects seen clinically following the insertion of orthodontic appliances into the oral cavity can contribute to chronic infection, inflammatory hyperplasia, irreversible loss of attachment (permanent bone loss), and gingival recession. Although an association between orthodontic tooth movement and gingival recession has been mentioned in both the orthodontic and the periodontal literature, many of these studies are relevant to mandibular incisor teeth. Some investigators have shown gingival recession to be associated with labial movement of the mandibular incisors and have therefore considered this movement as a risk factor for gingival recession,^[6,7] while others have found no such association between orthodontic tooth movement and gingival recession.^[8-11] Moreover, it is argued that preexisting mucogingival problems can be exacerbated with orthodontic force application.^[12]

The aim of this retrospective study was to evaluate the relationship between orthodontic therapy and gingival health. Different from the previous studies, we examined not only incisor teeth, but also all of the teeth from the point of gingival recession.

MATERIALS AND METHODS

From the pool of 440 records (personal records; age, sex, treatment time, etc., pre- and post-treatment intra-oral photographs, lateral cephalometric films) of patients who have completed orthodontic treatment carried out by postgraduate students at the Gazi University, Faculty of Dentistry, Department of Orthodontics. A total of 251 patients fulfilled the criteria to be included in this study. Patients with incomplete records were excluded.

All patients satisfied the selection criteria: Active treatment finished during the period between 2006 and 2012, less than 18 years of age, treatment complete, and pre- and post-treatment records available, pre- and post-treatment clinical intra-oral photographs have good quality. The exclusion criteria were as follows: Orthognathic surgery, lip and palate cleft and medicine intake.

The periodontal status, including visible plaque, visible inflammation, gingival biotype, gingival recession, was evaluated on intra-oral photographs. Each intra-oral color photograph (frontal, and sagittal view) was analyzed on the same screen in a dark room, and the following observations were recorded: (1) Presence or absence of visible plaque and (2) presence or absence

of visible inflammation at the mesial, buccal and distal sides of each teeth (except second and third molars) (3) presence or absence of labial gingival recession before and after orthodontic treatment.^[8] The gingival recession was classified according to the Miller's classification^[12] as assessed on color slides.

Gingival biotype was assessed on the pre- and post-treatment intra-oral photographs, buccal side of anterior teeth as thin or thick on the basis of visual inspection of the gingival texture and capillary transparency.^[13] If the lower lip covered the gingiva in the frontal view or photographs are not clear, the recording was considered unreadable.

The cephalometric analyses were done by one author using the angular and linear measurements. The initial and final cephalometric measurements made were as follows:

- The most labial surface of the lower incisor to nasion-B point ($\underline{1}/\text{NB}$ in millimeters)
- The long axis of the mandibular incisor to nasion-B point angle ($\underline{1}/\text{NB}$ in degrees)
- The most labial surface of the upper incisor to nasion-A point ($\underline{1}/\text{NA}$ in millimeters)
- The long axis of the maxillar incisor to nasion-A point angle ($\underline{1}/\text{NA}$ in degrees).

Intra-oral clinical photographs were evaluated by one experienced periodontologist, and cephalometric films were evaluated by one experienced orthodontist. For interexaminer consistency, examiners first measured the parameters of 30 patients, and then re-measured them in the same patients 10 days later: A high-degree of agreement was found between examinations (Cronbach's alpha: 0.99).

Statistical analysis

Data from all variables were transferred to the statistical program SPSS Base 15.0 (SPSS Inc., Chicago, USA). Descriptive statistic showed with the mean \pm standard deviation for the distribution of normal variables, median (min-max) for the distribution of nonnormal variables and the number of cases and percentages for the nominal variables. Significant difference between the groups in terms of arithmetic means was analyzed with Student's *t*-test (with Bonferroni correction), significant difference in terms of median values was analyzed with Mann-Whitney U-test (with Bonferroni correction). Nominal variables were assessed by using Pearson's Chi-square or Fisher's exact test. Intergroup differences between time periods were

investigated with Wilcoxon test (with Bonferroni correction) for the distribution of nonnormal variables, and paired *t*-test (with Bonferroni correction) for the distribution of normal variables. Spearman correlation analysis was used to determine a correlation coefficient and *P* value between incisor inclinations and gingival recession changes. $P \leq 0.05$ considered to be statistically significant.

RESULTS

A total of 251 patients (177 girls and 74 boys) fulfilled the criteria to be included in the study. The average chronological age of the group was 13.37 ± 2.06 years. In total 231 patients had been treated with fixed orthodontic appliances (58 of these with extraction and 173 of these without extraction) and 20 patients had been treated with functional appliances. The pretreatment demographic variables of patients are listed in Table 1. Although gender difference of the patients did not show any statistically differences

among the treatment groups, age and treatment time showed statistically differences.

Distributions of visible plaque, visible inflammation, gingival recession before and after in the functional and fixed orthodontic treatment groups are listed in Table 2, and gingival biotype is listed in Table 3. In patients treated with fixed orthodontic appliances, the mean value of visible plaque, visible inflammation, and gingival recession were 2.93 ± 6.78 , 2.76 ± 6.20 , and 0.11 ± 0.40 before treatment, respectively. All these parameters showed significant increases after treatment, and they were 5.92 ± 9.08 , 17.75 ± 18.74 , and 0.48 ± 1.13 , respectively. No statistically significant difference was found in patients treated with functional appliances before and after treatment [Table 2]. Similarly, gingival biotype did not show any significant differences before and after orthodontic treatment [Table 3]. None of these parameters showed significant change between girls and boys.

Table 1: Demographic variables

Demographic variables	Total (n=251)	Fixed appliance treatment		Functional appliance treatment (n=20)	P
		With extraction (n=58)	Without extraction (n=173)		
Age (year)					
Mean±SD	13.37±2.06	14.19±1.70	13.33±2.05	11.68±2.15	0.000*
Median (range)	8-17.8	10-17.8	8-17.8	9.1-15.8	
Sex (n (%))					
Girl	177 (70.51)	41 (70.68)	122 (70.52)	14 (70)	0.998
Boy	74 (29.48)	17 (29.32)	51 (29.48)	6 (30)	
Treatment time (month)					
Mean±SD	24.84±12.8	30.76±11.98	24.12±12.35	13.65±6.14	0.000*
Median (range)	21 (3-66)	30.50 (6-60)	20.0 (3-66)	13.0 (4-27)	
Angle classification (n (%))					
Class 1	116 (46.21)	20 (34.4)	94 (54.33)	2 (10)	
Class 2	106 (42.23)	30 (51.8)	65 (37.6)	11 (55)	
Class 3	29 (11.55)	8 (13.8)	14 (8.1)	7 (35)	

SD: Standard deviation, *: Statistically significant

Table 2: Distribution of visible plaque, visible inflammation and gingival recession values before and after treatment

Treatment groups	Visible plaque			Visible inflammation			Gingival recession		
	Before treatment	After treatment	P	Before treatment	After treatment	P	Before treatment	After treatment	P
Fixed appliance treatment									
Mean±SD	2.93±6.78	5.92±9.08	0.000*	2.76±6.20	17.75±18.74	0.000*	0.11±0.40	0.48±1.13	0.000*
Median (range)	0 (0-54.16)	0 (0-11.11)		0 (0-36.11)	0 (13.88-25.0)		0 (0-2)	0 (0-9)	
Functional appliance treatment									
Mean±SD	1.57±3.5	4.77±8.93	0.176	2.81±5.83	4.13±6.89	0.341	0.10±0.30	0.25±0.55	0.083
Median (range)	0 (0-10.71)	0 (0-31.94)		0 (0-16.66)	1.38 (0-29.16)		0 (0-1)	0 (0-2)	

SD: Standard deviation, *: Statistically significant

Of 231 patients, which had been treated with fixed orthodontic appliances; 173 of them had been treated without extraction and 58 of them with extraction. In both groups visible plaque, visible inflammation and gingival recession parameters showed statistically significant increases during orthodontic treatment. In the nonextraction group, the mean value of visible plaque, visible inflammation, and gingival recession were 3.21 ± 7.56 , 2.87 ± 6.51 , 0.12 ± 0.43 before treatment and 5.38 ± 9.25 , 18.21 ± 20.06 , 0.44 ± 0.96 after treatment, respectively. In the extraction group, the mean value of visible plaque, visible inflammation, and gingival recession were 2.09 ± 3.48 , 2.43 ± 5.22 , 0.07 ± 0.31 before treatment and 7.55 ± 8.45 , 16.37 ± 14.16 , 0.59 ± 1.53 after treatment, respectively [Table 4].

Gingival recession was also evaluated on tooth groups (incisors, cuspids, bicuspids and molars).

For this purpose, 4152 teeth (692 mandibular incisor, 692 maxillar incisor, 346 mandibular cuspid, 346 maxillar cuspid, 692 mandibular bicuspid, 692 maxillar bicuspid, 346 mandibular first molar and 346 maxillar first molar) in nonextraction group and 1160 teeth (232 mandibular incisor, 232 maxillar incisor, 116 mandibular cuspid, 116 maxillar cuspid, 116 mandibular bicuspid, 116 maxillar bicuspid, 116 mandibular first molar and 116 maxillar first molar) in extraction group (totally 5312 teeth) were evaluated in respect to gingival recession. In patients treated with extraction and nonextraction groups, gingival recession was found in 5 teeth (0.35%) before treatment and 35 teeth (2.51%) after treatment, and 21 teeth (0.50%) before treatment and 73 teeth (1.75%) after treatment, respectively. When the data were analyzed according to the tooth type, the cuspids were the most affected teeth [Tables 5 and 6]. They showed an increase in

Table 3: Distribution of gingival biotype in jaws before and after treatment

Treatment groups (n (%))	Maxilla				Mandible			
	Thin		Thick		Thin		Thick	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Fixed appliance treatment	83 (35.8)	77 (33.3)	148 (64.1)	154 (66.7)	148 (64.1)	147 (63.6)	83 (35.8)	84 (36.4)
Functional appliance treatment	7 (35)	7 (35)	13 (65)	13 (65)	12 (60)	8 (40)	13 (65)	7 (35)

Table 4: Distribution of visible plaque, visible inflammation and gingival recession values in the patients treated with and without extraction before and after treatment

Parameters of gingival assesment	Fixed appliance treatment					
	Without extraction (n=173)			With extraction (n=58)		
	Before treatment	After treatment	P<0.05	Before treatment	After treatment	P<0.05
Visible plaque						
Mean±SD	3.21±7.56	5.38±9.25	0.001*	2.09±3.48	7.55±8.45	0.000*
Median (range)	0 (0-54.16)	0 (0-69.44)		0 (0-12.5)	4.85 (0-27.7)	
Visible inflammation						
Mean±SD	2.87±6.51	18.21±20.06	0.000*	2.43±5.22	16.37±14.16	0.000*
Median (range)	0 (0-36.11)	13.88 (0-88.88)		0 (0-23.6)	13.88 (0-65.27)	
Gingival recession						
Mean±SD	0.12±0.43	0.44±0.96	0.000*	0.07±0.31	0.59±1.53	0.001*
Median (range)	0 (0-2)	0 (0-6)		0 (0-2)	0 (0-9)	

SD: Standard deviation, *: Statistically significant

Table 5: Number of teeth with gingival recession in patients treated with fixed orthodontic treatment with extraction

Fixed appliance treatment	n=232 (%)		n=116 (%)		n=232 (%)		n=116		Total (n=1392) (%)
	Mandibular incisor	Maxillar incisor	Mandibular cuspid	Maxillar cuspid	Mandibular bicuspid	Maxillar bicuspid	Mandibular molar	Maxillar molar	
With extraction									
Before treatment	1 (0.43)	2 (0.86)	2 (1.72)	0	0	0	0	0	5 (0.35)
After treatment	4 (1.72)	6 (2.59)	11 (9.48)	11 (9.48)	2 (0.86)	1 (0.43)	0	0	35 (2.51)

gingival recession about 9.48% for maxillary and 7.76% for mandibular cuspids in extraction group and 4.04% for maxillary and 3.76% for mandibular cuspids in nonextraction group. Cuspids without extraction group, upper incisors (with extraction group), upper incisors (without extraction group), lower incisors (with extraction group), upper bicuspid (without extraction group), lower bicuspid (with extraction group), lower bicuspid (without extraction group), lower incisors (without extraction group), and upper bicuspid (with extraction group) kept up with, respectively.

When the linear and angular cephalometric measurements of mandibular and maxillary incisors were assessed in the groups; all the parameters except 1/NA showed statistically significant difference [Table 7]. However, positive correlation was found between differentiation of 1/NB in millimeters and differentiation of gingival recession at mandibular incisor teeth in patients treated with extraction [Tables 8 and 9].

DISCUSSION

In this study, both of the visible plaque and gingival

inflammation values increased between the baseline and the end of treatment in all patients. These increases were statistically significant in patients treated with fixed orthodontic appliances. Our results are similar to the results of the previous studies, which showed that regardless of the quality of plaque control, most subjects undergoing fixed orthodontic treatment developed generalized gingivitis within a short time.^[3-5,14] Zachrisson and Zachrisson have reported that even after maintaining excellent oral hygiene, patients usually experience mild to moderate gingivitis within 1-2 months after appliance placement.^[3] Liu *et al.* suggested that fixed orthodontic treatment results in dental plaque accumulation and gingival inflammation, with a significant increase in Plaque Index (PI) and Gingival Index (GI) in a short time after orthodontic treatment started (compared to the baseline).^[15] Different from these studies, Davies *et al.*^[16] showed, in their study of the effects of orthodontic treatment on plaque and gingivitis that children who had received orthodontic treatment had lower plaque and gingivitis levels than children who had not received treatment. They concluded that regular visits to the orthodontist are the most likely reason for improvement in oral hygiene and gingival health.

Table 6: Number of teeth with gingival recession in patients treated with fixed orthodontic treatment without extraction

Fixed appliance treatment	n=692 (%)		n=346 (%)		n=692 (%)		n=346		Total (n=4152) (%)
	Mandibular incisor	Maxillar incisor	Mandibular cuspid	Maxillar cuspid	Mandibular bicuspid	Maxillar bicuspid	Mandibular molar	Maxillar molar	
Without extraction									
Before treatment	3 (0.43)	9 (1.45)	1 (0.29)	3 (0.87)	0	5 (0.72)	0	0	21 (0.50)
After treatment	7 (1.01)	18 (2.89)	14 (4.05)	17 (4.91)	5 (0.72)	12 (1.73)	0	0	73 (1.75)

Table 7: Statistical analysis of incisor inclinations before and after fixed orthodontic treatment

Incisor inclinations	Fixed appliance treatment						
	Without extraction (n=173)			P<0.05	With extraction (n=58)		
	Before treatment	After treatment			Before treatment	After treatment	P<0.05
1/NB (°)							
Mean±SD	24.26±6.29	26.38±5.65	0.000*	25.69±6.42	23.11±6.24	0.003*	
Median (range)	25 (4-37)	26.8 (10-38.5)		26 (12-39)	27 (6-35)		
1/NB (mm)							
Mean±SD	5.43±10.4	5.82±78.09	0.000*	5.87±2.37	5.29±2.23	0.043*	
Median (range)	5 (-2-12)	6 (-1.5-12)		5.75 (1-11.5)	5.5 (0-1, 5-10)		
1/NA (°)							
Mean±SD	23.76±6.29	25.73±6.34	0.000*	24.28±6.66	22.23±7.92	0.57	
Median (range)							
1/NA (mm)							
Mean±SD	5.09±2.40	5.87±2.15	0.000*	5.43±2.53	4.33±2.97	0.004*	
Median (range)	5 (0-13)	6 (1-11)		5.75 (0-11)	4 (0-14)		

SD: Standard deviation, *: Statistically significant

Table 8: Correlation between chance of gingival recession at mandibular incisors and change of $\bar{1}/\text{NB}$ (°) and change of $\bar{1}/\text{NB}$ (mm)

Fixed appliance treatment	Change of $\bar{1}/\text{NB}$ (°)	Change of $\bar{1}/\text{NB}$ (mm)
With extraction		
Change of gingival recession		
Correlation coefficient	0.178	0.261
Significant (two-tailed)	0.181	0.048*
Without extraction		
Change of gingival recession		
Correlation coefficient	0.061	0.080
Significant (two-tailed)	0.425	0.292
*: Statistically significant		

Table 9: Correlation between change of gingival recession at maxillary incisors and change of $\bar{1}/\text{NA}$ (°) and change of $\bar{1}/\text{NA}$ (mm)

Fixed appliance treatment	Change of $\bar{1}/\text{NA}$ (°)	Change of $\bar{1}/\text{NA}$ (mm)
With extraction		
Change of gingival recession		
Correlation coefficient	-0.47	0.069
Significant (two-tailed)	0.727	0.605
Without extraction		
Change of gingival recession		
Correlation coefficient	0.146	-0.028
Significant (two-tailed)	0.055	0.715

It must also be kept in mind that many of the subjects in this study were in the circumpubertal age range. It has been shown that gingival inflammation and gingival bleeding will increase in children at pubertal age as a result of the hormone changes that occur during puberty.^[17] However, in patients treated with functional appliances increases in these parameters after treatment were not statistically significant. This may be due to the small number of patients treated with functional appliances.

When the present clinical results are compared with many of the previous investigations, it should be noted that in this study, all parameters were assessed on color slides at the three surface of (mesial, buccal, and distal) all teeth except second and third molars. The evaluation of gingival inflammation and plaque on color slides compared with a gold standard clinical evaluation is questionable, but a high-degree of agreement was found between examinations. Sallum *et al.* have reported a significant reduction in plaque index, bleeding on probing, and probing depth, the three most important parameters indicating clinical gingival health, once orthodontic appliances are removed. In

this study, photographs had been taken immediately after debonding.^[18] Measurements may be affected, by often observed gingival inflammation and swelling, because of the difficulty in oral hygiene during the treatment.

An association between orthodontic tooth movement and gingival recession has been mentioned in both orthodontic and periodontal literature, with some reports arguing on behalf of a causal connection and others arguing against it.^[6-8] Most studies which investigate gingival recessions reported that periodontal tissue in younger patients has a more favorable response to orthodontic treatment than in older adolescents and adults.^[9-11] Therefore, the age limit in our study was set at 18 years at baseline of orthodontic treatment. Vassali *et al.* suggested that treatment duration, treatment type, the skeletal or dental relationship, age, sex or race did not have an influence on the development of recessions during treatment. Presence of gingival inflammation and baseline recession,^[9] a thin gingival biotype,^[9,19] a narrow width of keratinized gingiva,^[6,9,19] or a thin symphysis^[20] were found to correlate significantly with the development or increase in gingival recession. Melsen and Allais^[9] demonstrated that gingival morphology is an important factor in recession after orthodontic proclination, but they gave no values to define qualitative parameters as thin or thick gingival biotype. In this study, we did not find any correlation between gingival recession and visible plaque, visible inflammation, gingival biotype, but found a positive correlation between lower incisor position.

The evaluation of gingival recessions in this study was carried out only on color slides according to the Miller classification. This method proved to be reliable, reproducible, and informative.^[9] It has been shown that most cases of gingival recession, which occur during an orthodontic treatment are seen in regions of the anterior upper and lower teeth. Proclination of the lower incisors during orthodontic treatment has been considered to be detrimental to periodontal health.^[7,20,21] Doffman concluded that more proclined teeth had a higher occurrence or severity of gingival recession compared with less proclined or untreated teeth. However, the differences were small and the clinical consequences questionable.^[22]

In this study, gingival recession increased from 0.43% to 1.72% in lower incisors and from 0.86% to 2.59%

in upper incisors for extraction group; from 0.43% to 1.01% in lower incisors and from 1.45% to 2.89% in upper incisors for nonextraction group. Results from an experimental study indicate that as long as the tooth is moved within the envelope of the alveolar process, the risk of harmful side-effects on the marginal soft tissue is minimal.^[7] We found a significant correlation between recession and lower incisor retrusion. This may be due to the change of axial inclination of lower teeth during incisor retraction in extraction cases.

In this study, cuspids were the teeth with the highest prevalence of gingival recession. This differs from the results of other studies, which investigated the relationships between orthodontic treatment and gingival recession. Our results are consistent with a previous study, which was showed that gingival recession more frequently occurs in upper cuspid, upper bicuspid, lower cuspid, and lower bicuspid teeth.^[23] In addition, the developmental position of the teeth also seems to be important as a predisposing factor to local gingival recession.^[12,24] Usually, the canins were in a more upper position at maxilla or vestibular position at mandible and it might result in a thin labial bone plate and marginal gingiva. Because of this investigation was a retrospective study the relationship between cuspids or bicuspid's movement and gingival recession could not be evaluated with limited material. Hence, more controlled prospective studies should be planned to evaluate the relationship between the three-dimensional tooth movement of these teeth and gingival recession.

CONCLUSIONS

This study showed:

- The mean value of visible plaque and visible inflammation showed significant increases during orthodontic treatment. Therefore, prior to orthodontic treatment, patients should have a high level of periodontal health and it should be maintained during the treatment period.
- Positive correlation was found between lower incisor retraction and gingival recession. Hence, lower incisor inclination change should be evaluated with more controlled prospective studies during orthodontic treatment in order to prevent harmful side-effects.
- The cuspids were the teeth with the highest prevalence of gingival recession. Hence, more controlled prospective studies should be planned to evaluate the relationship between the three-dimensional tooth movement of these teeth and gingival recession
- Considering the relationship between orthodontic treatment and gingival health, patients, orthodontists and periodontists should cooperate during orthodontic treatment.

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