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THE EFFECTS OF FIXED ORTHODONTIC TREATMENT PERIOD ON WHITE SPOT LESION PREVALENCE AND DMFT INDEX

Sabit Ortodontik Tedavi Süresinin Beyaz Nokta Lezyonu Oluşum Sıklığı ve DMFT İndeksi Üzerine Etkileri

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ABSTRACT

Purpose: The purpose of this study was to assess the effects of fixed orthodontic treatment duration on DMFT (D: decay, F: filling and M: missing teeth) index and white spot lesion (WSL) formation.

Materials and Methods: Eighty four patients (45 females and 39 males, 13-18 years old, mean age: 14.7±0.8) who were undergoing fixed orthodontic treatment were invited to participate in this study. All patients were treated with a 0.018 inch slot MBT fixed orthodontic appliances. An examiner used the Gorelick index for assessment of white spot lesion (WSL) on the buccal surface of teeth before (T1) and after (T2) treatment. The World Health Organization (WHO) criteria were utilized to diagnose the carious status (DMFT) of the subjects. Subjects were divided into three groups according to treatment durations (Group A:0-18 months, Group B: between 18-30 months and Group C: more than 30 months).

Results: The prevalence of WSL was 15.4% at T1 in all groups. After treatment (T2), 69% of patients presented WSL. The incidence of patients who developed at least one new WSL during fixed orthodontic treatment was 53.6%. The greatest prevalence of WSLs was found in the mandibular first molars (20.6%), followed by the maxillary lateral incisors (16.3%) and the mandibular second premolars (13.7%). There were significant differences in the prevalence of WSLs ($p<0.01$) and DMFT index ($p<0.01$) between Group C and other two groups (Group A and Group B).

Conclusion: The results showed that patients whose orthodontic treatment was longer than 30 months are at higher risk for white spot formation and DMFT index. White spot lesion formation should be prevented with caries preventive applications and effective oral care support in these patients.

Keywords: *DMFT index, white spot lesion, orthodontic appliances*

ÖZ

Amaç: Bu çalışmanın amacı sabit ortodontik tedavi süresinin DMFT (D: çürük, F: dolgulu ve M: eksik diş sayısı) indeksi ve beyaz nokta lezyonu oluşum sıklığı üzerine etkisini değerlendirmektir.

Gereç ve Yöntem: Sabit ortodontik tedavi gören 84 birey (45 kız, 38 erkek, 13-18 yaş, ortalama yaş 14.7±0.8) bu çalışma kapsamında değerlendirildi. Bütün hastalar 0,018 inç slot MBT sabit ortodontik apareyler ile tedavi edildi. Bireyler tedavi başlangıcında (T1) ve tedavi bitiminde (T2) bir araştırmacı tarafından beyaz nokta lezyonu (BNL) görülme sıklığının tespiti amacıyla Gorelick indeksine göre klinikte muayene edildi. DMFT indeksi değerlendirmesinde klinik muayenede Dünya Sağlık Örgütü (DSÖ) kriterleri kullanıldı. Bireyler sabit ortodontik tedavi görme sürelerine göre (Grup A: 0-18 ay, Grup B:18-30 ay ve Grup C: >30 ay) üç alt gruba ayrıldı.

Bulgular: 84 bireyde T1' de BNL görülme sıklığı % 15.4 iken, T2' de % 69.0' a yükseldiği ve insidans hızının % 53.6 olduğu bulundu. Yeni oluşan lezyonların en çok alt birinci büyük azı dişlerinde (% 20.6) oluştuğu, bunu üst lateral dişler (% 16.3) ve alt ikinci küçük azı dişlerin (% 13.7) takip ettiği görüldü. T2 sonuçlarına göre; Grup C ve diğer iki grup arasında (Grup A ve Grup B) DMFT ortalaması ($p<0.05$) ve BNL oluşum sıklığı ($p<0.05$) açısından anlamlı fark olduğu bulundu.

Sonuç: 30 aydan daha uzun süren ortodonti tedavisinde bireylerin DMFT değerinin ve BNL oluşturma riskinin anlamlı derecede yükseldiği görülmektedir. Bu durumdaki bireylere daha etkili bir ağız bakım desteği sağlanmalı ve çürükten koruyucu uygulamalar yapılmalıdır.

Anahtar kelimeler: *DMFT indeksi, beyaz nokta lezyonu, ortodontik apareyler*

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Introduction

White spot lesion formation is a common iatrogenic effect seen in patients undergoing orthodontic treatment with fixed appliances. The overall prevalence of WSL among orthodontic patients has been reported as anywhere between 2% and 97% (1). Individuals with malocclusions often have many plaque retention sites due to the irregularities of their teeth. Orthodontic treatment with fixed appliances and complex loop designs further increases the risk for development of WSL due to the creation of additional retention sites on surfaces generally not susceptible to caries (2). Furthermore, the parts of fixed appliances like brackets, bands, and wires have irregular surfaces that limit the naturally occurring self-cleansing mechanisms of the oral musculature and saliva (3). Despite intensive efforts to educate patients about effective oral hygiene procedures, WSL associated with fixed orthodontic appliances remains a significant clinical problem (2). Orthodontic patients have significantly more WSL than non-orthodontic patients and these WSLs may cause to deterioration of teeth and esthetic concerns even after years of treatment (3).

Patients undergoing treatment with fixed orthodontic appliances have a rapid increase in the volume of dental plaque and such a plaque has a lower pH than that found in non-orthodontic patients (4, 5). There is a rapid shift in the composition of the bacterial flora of the plaque following the introduction of orthodontic appliances (5). More specifically, the levels of acidogenic bacteria, such as Streptococcus mutans and Lactobacillus, become significantly elevated in orthodontic patients. If these bacteria have an adequate supply of fermentable carbohydrates, acid by-products will be produced a lower pH of the plaque (6). Some previous studies showed increased caries frequency with a higher prevalence of fillings in subjects receiving orthodontic treatment, whereas more recent investigations did not confirm such correlation (7, 8).

There is no consensus in the literature about the effect of orthodontic treatment length on the caries risk and WSL formation. Richter et al. (9) determined that duration of orthodontic treatment was a significant factor for WSL development. Chapman et al. (10) found that longer treatment duration was significantly related to increased number of non cavitated lesions. On the other hand, some authors (11, 12) suggested that treatment length was not a significant factor in WSL development. However, to the best of our knowledge, no study has reported the effects of fixed orthodontic treatment duration on the caries risk and WSL formation, together. The aims of this study were (a) to evaluate the prevalence and incidence of white spot lesions among patients undergoing orthodontic treatment with fixed appliances, (b) to analyze which teeth are more affected by WSL and (c) to investigate the effect of orthodontic treatment length on DMFT index and WSL prevalence.

Materials and Methods

The study was performed in the Departments of Restorative Dentistry and Orthodontics, Faculty of Dentistry, Selcuk University, Konya, Turkey. A sample of 84 patients (45 females and 39 males, 13-18 years old, mean age: 14.7±0.8) who were undergoing fixed orthodontic treatment in Department of Orthodontics participated in this study. Informed consent was obtained from all participants and their parents prior to study. The patients with any systemic dis-

ease, smoking habits, plaque accumulation and periodontal disease, enamel hypoplasia, dental fluorosis or intrinsic and extrinsic pigmentation, no brushing habits before bedtime, high caries activity (such as low saliva secretion rates, DMFT>7) and who had orthodontic treatment before were excluded from the study.

All patients were treated with 0.018 inch slot MBT fixed orthodontic appliances (Equilibrium® 2, Dentaurum, Germany), and their teeth were bonded with a light-cured composite resin and adhesive (Transbond XT; 3M Unitek, Monrovia, Calif, USA). Each patient was given the same instructions with respect to oral hygiene. All patients received the usual home-care oral hygiene instructions and a packet with nonprescription fluoride toothpaste (1450 ppm of fluoride; Colgate Total, 1450 ppm F, São Paulo, Brazil), a manual toothbrush, and dental floss (Colgate Total, São Paulo, Brazil). Four weeks after bracket placement, all patients received thorough prophylaxis. Caries risk level (DMFT) and WSL examination were performed before (T1) and after (T2) fixed orthodontic treatment.Caries experience is reported as DMFT to assess the patient's risk level, based on clinical findings. The WHO criteria were utilized to diagnose the carious status of the subjects (9) Clinical examination was made using a plane mouth mirror and blunt, sickle probe with the aid of a dental chair light on dried teeth by one examiner. The sickle probe was used to remove debris, check restoration margins and detect cavitations. In clinical examination, diagnosis of caries was made only when there was clear evidence of loss of tooth substance. The congenitally missing or extracted teeth were excluded from data collection. Therefore, a maximum of 28 teeth were examined per subject for DMFT index score (2352 teeth in total).

The modified Gorelick WSL index (12) was used with the aid of standard 3.0x loupe (Keeler Corporation, England) for visual evaluation of the buccal surfaces of the anterior teeth, premolars, and first molars (24 teeth) in the upper and lower jaws (Table 1).

Table 1. Modified Gorelick index (12).

Score 0:	no visible white spot or surface disruption (no demineralization)
Score 1:	visible WSL that covered less than one-third of the surface, without surface disruption (mild demineralization)
Score 2:	visible WSL that covered more than one-third of the surface, with a roughened surface but not requiring restoration (moderate demineralization)
Score 3:	visible cavitation: restoration + (severe demineralization)

Subjects who had at least one WSL were recorded as code 1. On the other hand, subjects who didn't have any signs of WSL were recorded as code 0. The scoring was performed under direct illumination using a dental lamp after light pumicing and drying with compressed air for 5 seconds. Measurements were performed on all patients who were enrolled in the study by the same operator. The clinician was blinded to the time frame for orthodontic therapy and evaluated the subjects only after another assistant had removed the wires from the appliance.

The subjects were divided into three groups according to the treatment time (Group A: 0-18 months, Group B: between

18-30 months and Group C: more than 30 months) after recording of all data. The increasing DMFT and WSL index was determined at T1 and T2. All statistics were performed with SPSS version 17.0 (SPSS Inc, Chicago, IL, USA). Because the scoring system was used for determination, non-parametric tests were used for statistical analysis (11). Descriptive statistics were obtained for all groups. Kruskal-Wallis, Mann-Whitney U tests and Dunn's multiple comparisons tests were used to compare the groups for DMFT index. Chi-Square test was used for differences about WSL. Simple linear regression between DMFT-T1 and DMFT-T2 was used to clean the effect of the DMFT-T1 on DMFT-T2. The unstandardized and studentized residuals were compared using Kruskal-Wallis test.

Results

The prevalence of WSL was 15.4% at T1, 69% of patients presented WSL at T2. The incidence of patients who developed at least one new WSL during treatment was 53.6%. The mean DMFT index was 2.57 at T1, while 3.51 at T2. The mean DMFT and WSL prevalence were not associated with gender at T1 and T2 (Table 2).

Table 2. Differences between male and female patients in relation to WSL formation and DMFT index (F: Female, M: Male, Min: Minimum, Max: Maximum).

		DMFT					WSL (Number of Subject)			
Time	Gender	Mean ± SD	Min	Max	Total	p-value	Present	Absent	Total	p-value
T1	F	2.68 ± 1.99	0	6	2.57 ± 1.87	0.707	7 (15.5%)	38 (84.5%)	45 (100%)	0.612
	M	2.43 ± 1.72	0	7			6 (15.3%)	33 (84.2%)	39 (100%)	
T2	F	3.64 ± 2.72	0	12	3.51 ± 2.48	0.637	31 (68.8%)	14 (31.2%)	45 (100%)	0.581
	M	3.35 ± 2.20	0	9			27 (69.2%)	12 (30.8%)	39 (100%)	

WSL was observed only 40 teeth at T1 and 97% of them were found to be mild WSL, while at T2 this number increased to 392 teeth. Of all 392 teeth, 69.6% had only mild WSL and the remaining teeth were affected severely, either with severe (22.4%) WSL or with restoration + (8%) WSL (Table 3).

Table 3. WSL number and severity at different times.

	WSL (Teeth)				
Time	Absent	Present			
		Mild	Severe	Restoration +	Total
T1	1976	39 (97%)	1 (3%)	0	2016
		Total: 40 (100%)			
T2	1571	273 (69.6%)	88 (22.4%)	31 (8%)	1963 *
		Total: 392 (100%)			

Note: (: number of extracted teeth during orthodontic treatment: 53)*

Among the subjects, the greatest prevalence of WSLs was found in the lower first molars (20.6%), followed by the upper lateral incisors (16.3%) and the lower second premolars (13.7%). The prevalence of WSLs on different types of teeth is shown in (Table 4).

Table 4. Frequency of WSL on different types of teeth.

WSL (upper teeth)	T1	T2	WSL (lower teeth)	T1	T2
11+21	1	19 (4.8%)	**31+41**	1	4 (1%)
12+22	8	64 (16.3%)	**32+42**	0	15 (3.8%)
13+23	0	32 (8.1%)	**33+43**	0	29 (7.2%)
14+24	1	13 (3.3%)	**34+44**	3	37 (9.4%)
15+25	2	28 (7.1%)	**35+45**	4	54 (13.7%)
16+26	1	15 (3.8%)	**36+46**	19	81 (20.6%)
Number of teeth with WSL; T1: 40 teeth**, T2:** 392 teeth					

The number of subjects was 49 in Group A, while 13 in Group B and 22 in Group C. Mean treatment duration was 16.88 ± 1.53 months in Group A, 22.6 ± 2.78 months in Group B and 33.12 ± 2.69 months in Group C. Group C showed significantly higher mean DMFT increase (2.55) compared to the Group A (0.24) and Group B (0.85) ($p<0.01$). In linear regression model, DMFT-T2 value was chosen as dependent and DMFT-T1 variable was chosen as independent variable. The constructed model was as it follows:

DMFT-T2=0.721 + 1.086 * DMFT-T1

The model was statistically significant (F= 164.6; R2= 0.663; $p<0.001$) and the coefficients for constants 0.721 and independent variable 1.086 were also statistically significant (tcons= 2.683; tindp=12.83; $p<0.05$). The means of the residuals within groups were found statistically different ($p<0.001$). Pairwise comparisons were done and Group C was different from Group A and Group B ($p<0.05$). The WSL prevalence was 59.1% in Group A, 69.2% in Group B and 91% in Group C at T2. Significant differences was found in the number of WSLs between the groups ($p<0.01$), (Table 5).

Table 5. Differences between groups in relation to WSL formation and DMFT index.

Time		DMFT				WSL (Number of Subject)			
	Groups	Mean ± SD	Min	Max	p-value	Present	Absent	Total	p-value
T1	Group A	2.53 ± 2.00[a]	0	7	0.841	7 (14.2%)[ab]	42 (85.8%)	**49 (100%)**	0.030
	Group B	2.61± 0.96[a]	2	4		0[a]	13 (100%)	**13 (100%)**	
	Group C	2.63 ± 2.03[a]	0	6		6 (27.2%)[b]	16 (72.8%)	**22 (100%)**	
T2	Group A	2.77 ± 2.12[a]	0	8	0.001	29 (59.1%)[a]	20 (40.9%)	**49 (100%)**	0.017
	Group B	3.46 ± 0.77[a]	3	5		9 (69.2%)[a]	4 (30.8%)	**13 (100%)**	
	Group C	5.18 ± 3.09[b]	0	12		20 (91%)[b]	2 (9%)	**22 (100%)**	

Note: *There was no statistically significant difference between the groups that have same letter ($p<0.05$).*

Discussion

The purpose of the present study was to assess the effect of fixed orthodontic treatment duration on DMFT index and WSL formation. It is well known that past caries experience is the strongest predictor of future caries development among school children and adolescents. Since the incidence and prevalence of caries is greater in fixed orthodontic patients, clinicians need a head start in this field such as various tools and methods other than clinical findings to predict the occurrence of new caries before frank cavitation. There is also a need for clinical flexibility while predicting caries according to DMFT scores at baseline and at the end of the treatment (9).

On the other hand, accurate evaluation of demineralized WSL during orthodontic treatment is important, so they might implement early prevention and/or treatment (13). To date, clinical detection of WSLs has been carried out primarily by means of traditional methods such as visual inspection with Gorelick index after air drying and tactile examination by dental probing. However, the subjectivity and lack of reproducibility of these approaches, together with the prerequisite of the presence of a significantly advanced lesion, have led to the introduction of several optical techniques during recent decades: the optical caries monitor, use of quantitative laser and light-induced fluorescence, digital imaging with fiber-optic transillumination, laser fluorescence, and computer analysis of digital photographs (14-18). Because of the nonexistence of these techniques, we consider that visual inspection was appropriate in the present study.

The WSL prevalence before treatment (15.4%) is in the range reported in previous studies by Akın et al. (11), Gorelick et al. (12) and Enaia et al. (18) for untreated control groups. In contrast, Øgaard (14) reported much higher WSL prevalence before treatment (from 70.4% to 85%). The WSL incidence in our study was 53.6%, resulting in a WSL prevalence of 69% after orthodontic treatment (18). Increased WSL incidence or changes in WSL prevalence after treatment have been reported previously with a variety of WSL evaluation methods, inclusion criteria, and prophylactic measures (11, 12, 14, 18). Akın et al. (11) found incidence of WSL to be 55% and prevalence of WSL 65%

after treatment, but they used intraoral photographs. In general, the prevalence of WSL in patients after orthodontic treatment varies from 15% to 85% (19), with most studies reporting 50% to 70% (14). The variation in WSL prevalence among studies could be attributed to differences in the number of teeth examined, the methods and the standardizations of examinations, the location of the study sample (cultural differences), time era of the study, age at the start of treatment, treatment duration, and materials (10).

The reported incidence and prevalence of WSL between males and females have been found to be inconclusive (11, 20). Our findings differ from the results of the study by Tufekci et al. (20) in which, it was reported that male (76%) patients experienced significantly greater increases in the severity of enamel opacities and prevalence of WSL formation than did female patients (24%). Akın et al. (11) concluded that gender was not significant factor in WSL development. However, a more recent study by Boersma et al. (1) reported that 40% of the buccal surfaces had demineralization in males, which is 18% more compared with females (22%). One possible explanation for these results is that females are generally more compliant orthodontic patients (20). Our results showed that females have higher mean DMFT values than males at two time points. However, there is recently some evidence to suggest that the higher DMFT values among females may also attribute to changes in salivary rates and composition induced by hormonal fluctuations among females (21).

Ninety-seven percent of teeth with WSL had mild lesions before treatment. However, 69.6% of teeth with WSL had mild and 22.4% of them had moderate lesions after treatment. Almost all other authors who observed WSL before and after fixed orthodontic treatment reported similar findings (11, 12, 19). Generally previous studies and also the present study have been designed to determine the prevalence or incidence of WSL in same clinic (9) and it was aimed to provide the standardization in some factors such as geographic and socioeconomic status (11).

There is still some controversy about the frequency of WSLs on different types of teeth. In the present study, there was a high prevalence of WSLs on lower first molars and upper lateral incisors, followed in decreasing order by lower second premolars, lower first premolars, upper and lower canines, upper second premolars and central incisors. Our analysis supports the results of Gorelick et al. (12), who reported that the most commonly affected teeth were upper lateral incisors and lower first molars, and the results of Chapman et al. (10), who showed that the order of incidence was lateral incisors, canines, premolars, and central incisors. The short distance between the bracket and the gingiva especially on the lateral incisors or lower first molars makes oral hygiene difficult. Further, it has been shown that the pH in plaque on the upper incisors and lower first molars is lower than in other regions of the dentition. This is probably because of low salivary clearance in the area. The results of the study by Geiger et al. (22) also agree with our conclusions, showing that lesions occurred most frequently on upper lateral incisors, lower first molars, and canines. In contrast, Øgaard (14) concluded that upper and lower first molars were the most commonly affected teeth for WSL.

Our study showed that there was relation between prevalence of WSLs and DMFT index and length of orthodontic treatment. Prevalence and caries risk were the highest when treatment durations were 30 months

and more. There is no study in the literature about the relation of orthodontic treatment duration and DMFT index. Some authors (9, 24) suggested that orthodontic treatment with a fixed appliance may be compatible with an increased incidence of caries, and thus orthodontic treatment itself has always been criticized. Some authors, (10, 23) however, found no relationship between fixed orthodontic treatment and caries experience. But none of these studies (23, 24) reported any relation between treatment length and caries risk. Cantekin et al. (24) suggested that DMFT counts increased in a group of young dental patients undergoing orthodontic therapy. Only Ahmed et al. (25) found increased prevalence of caries with the time period of orthodontic treatment. According to their report, the prevalence of caries was 33% in 6 months and 61% in 12 months duration of treatment.

Finally, Richter et al. (9) found that longer treatment length was not significantly related to increased WSL formation. The results of our study are not consistent with their study. On the other hand, Chapman et al. (10) determined that treatment length was significant factors in WSL development, consistent with the present study. Akın et al. (11) reported that treatment length was not a significant factor in WSL development.

Conclusion

The results showed that patients whose orthodontic treatment was longer than 30 months are at higher risk for white spot lesion development and DMFT index. To prevent development of WSLs, orthodontists should assess each patient's risk factors before and during treatment and modern orthodontic treatment should also be supported by local fluoride treatment, tooth-brushing instructions, and supervision of the oral hygiene of patients.

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