Original Article

Effects of adhesive flash-free brackets on enamel demineralization and periodontal status

Ayten Tan[a]; Serpil Çokakoğlu[b]

ABSTRACT

Objectives: To evaluate the effects of adhesive precoated (APC) flash-free brackets on enamel demineralization and periodontal status in patients during fixed orthodontic treatment.

Materials and Methods: Thirty patients, age 12 to 18 years, who had Angle Class I or Class II malocclusion with mild to moderate crowding in the permanent dentition were selected for this study. APC flash-free and conventional ceramic brackets were bonded for a split-mouth study design. The quadrant allocation was randomized. Demineralization records were obtained immediately after bonding (T0), 1 month after bonding (T1), and 6 months after bonding (T2). Clinical periodontal measurements, including gingival index, plaque index, and bleeding upon probing, were obtained before bonding (T0) and at the same time points (T1 and T2). Data were analyzed using Mann-Whitney *U* and Friedman tests to compare parameters between groups and times.

Results: Demineralization values decreased on most sides of the brackets for both groups between T0 and T1. In the conventional group, there was significantly higher demineralization on more sides compared with flash-free brackets between T1 and T2. With one exception, the decreased values were found in the incisal/occlusal sides of all brackets at T2. All periodontal parameters showed significant increases after 6 months of treatment in both groups. Intergroup comparison showed no significant differences in demineralization or periodontal measurements at any of the time points.

Conclusions: The effects of APC flash-free and conventional brackets on enamel demineralization and periodontal health did not differ from each other. (*Angle Orthod.* 2020;90:339–346.)

KEY WORDS: Flash-free; Demineralization; Periodontal health

INTRODUCTION

Orthodontic attachments used in clinical practice make oral hygiene difficult. During bonding, composites are not always able to be efficiently removed around the brackets, and these retentive areas cause the development of enamel demineralization by increasing plaque accumulation.[1]

With the recent developments in material science, manufacturers have introduced adhesive precoated (APC) flash-free brackets that eliminate the removal of excessive adhesive. This new era in bonding materialized in a nonwoven mat that is soaked with a relatively low viscosity adhesive resin and consists of randomly oriented and entangled polypropylene fibers in the bracket base. This structure is compressed and the leaked resin fills the gap between the base and enamel surface. In addition to shorter chair time, adequate bond strength and shorter clean-up time, the possibility of better oral hygiene owing to the protective effects of the adhesive and the decrease in retentive sites for plaque accumulation, are favorable aspects of flash-free brackets.[2–4]

In a first clinical and microscopic study, Foersch et al.[2] reported that smooth marginal surfaces of the adhesive in flash-free brackets might provide a protective effect against demineralization around the bracket sides. On the other hand, Jung et al.[5] emphasized that the movement of flash-free brackets on the tooth's surface might increase plaque accumu-

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lation caused by a gap in the direction of slip during the bracket positioning process.

Enamel demineralization associated with fixed orthodontic treatment is an extremely rapid process and visible white spot lesions (WSLs) can be noticed within 4 weeks.[6,7] Upon literature review, only a few studies have explained that gingival areas were the most frequently affected regions from WSLs on maxillary and mandibular teeth.[8–10] Many studies have shown that oral-hygiene parameters are closely related to the occurrence of WSLs during fixed orthodontic treatment.[11–13] However, no study has evaluated the effects of flash-free brackets on these parameters taking into account the bracket sides.

The aim of this prospective clinical study was to investigate the effects of flash-free brackets on enamel demineralization and periodontal health in patients with fixed orthodontic treatment. The null hypothesis was that flash-free brackets had no effect on these parameters.

MATERIALS AND METHODS

Ethical approval was obtained from the Ethics Committee, Pamukkale University (24.10.2017/14). The study population was composed of 30 patients (20 female, 10 male) referred with the need for orthodontic treatment. Informed consent was obtained from all participants. Patients between 12 and 18 years old were included based on the following criteria: (1) no systemic or periodontal problems; (2) indication of nonextraction fixed orthodontic treatment with Class I or Class II malocclusion with mild-to-moderate crowding; (3) permanent dentition with the absence of defects or clinically observable demineralization areas on vestibular/buccal surfaces; (4) absence of rotated teeth that affect true bracket positioning during bonding; and (5) no previous orthodontic treatment.

APC flash-free and conventional ceramic brackets were bonded with a split mouth study design on patients by the same researcher (A.T.) (Figure 1). Simple quadrant randomization was performed by the second author. During the bonding procedure, 37% phosphoric acid (Pulpdent Etch Royale, Pulpdent Corporation, Watertown, Mass) was used for enamel etching, Transbond XT Primer (3M Unitek, Monrovia, Calif) was applied to the etched enamel, and Transbond XT Light Cure Adhesive (3M Unitek) was used in the bonding of adhesive-free ceramic brackets. During this study excessive adhesives were removed carefully with the help of a scaler in the conventional group.

Elastomeric ligatures were used, and no additional application (eg, laceback, elastomeric chain and push coil) was made during the study. All patients received standard oral hygiene instructions to maintain their routine oral hygiene procedures.

The demineralization records were obtained immediately after bonding (T0), one month after bonding (T1), and 6 months after bonding (T2). The clinical periodontal measurements, including gingival index (GI), plaque index (PI) and bleeding on probing (BOP), were obtained before the placement of brackets (T0) and at the same times (T1 and T2) by the same researcher (AT). After the first periodontal records, the patients were bonded immediately, and then the first demineralization measurements were made.

Demineralization Measurements

The Diagnodent Pen (Kavo, Biberach, Germany) was used to evaluate enamel demineralization. According to the manufacturer, 0-12 was considered low risk, medium was 13-24, and $>$ 25 was high for demineralization. Repeated measurements of enamel demineralization were taken at four sites (distal, gingival, mesial and incisal/occlusal) of all brackets at T1 and T2, following the management of saliva control and dying of tooth surfaces. For these measurements, archwires were taken out and then debris and plaque were removed on vestibular surfaces by brushing without toothpaste.

The fissure tip of the device was placed perpendicularly to the enamel surfaces during the measurements. The calibrated probe was moved several times forward-backward and up-down for gingival or occlusal/incisal and mesial or distal sites, respectively. Then, the peak value was recorded. Two measurements were taken from one bracket side and the average was determined (Figure 2).

Periodontal Measurements

To determine periodontal status, GI,[14] PI,[15] and BOP[16] scores were recorded. Gingival inflammation was recorded as BOP scores if bleeding occurred within 30 seconds of probing. Bleeding upon probing was estimated as a percentage.

Statistical Analysis

Power analysis showed that, for a power of 0.80 with 0.50 effect size and at $\alpha = 0.05$ significance level, 27 patients would be required for each group. The records were statistically analyzed by using SPSS version 24.0 (IBM Corp., Armonk, NY). Data were analyzed by using Mann-Whitney *U* and Friedman tests for the comparison of parameters between groups and times. All tests were performed with a significance level of $P < 0.05$.

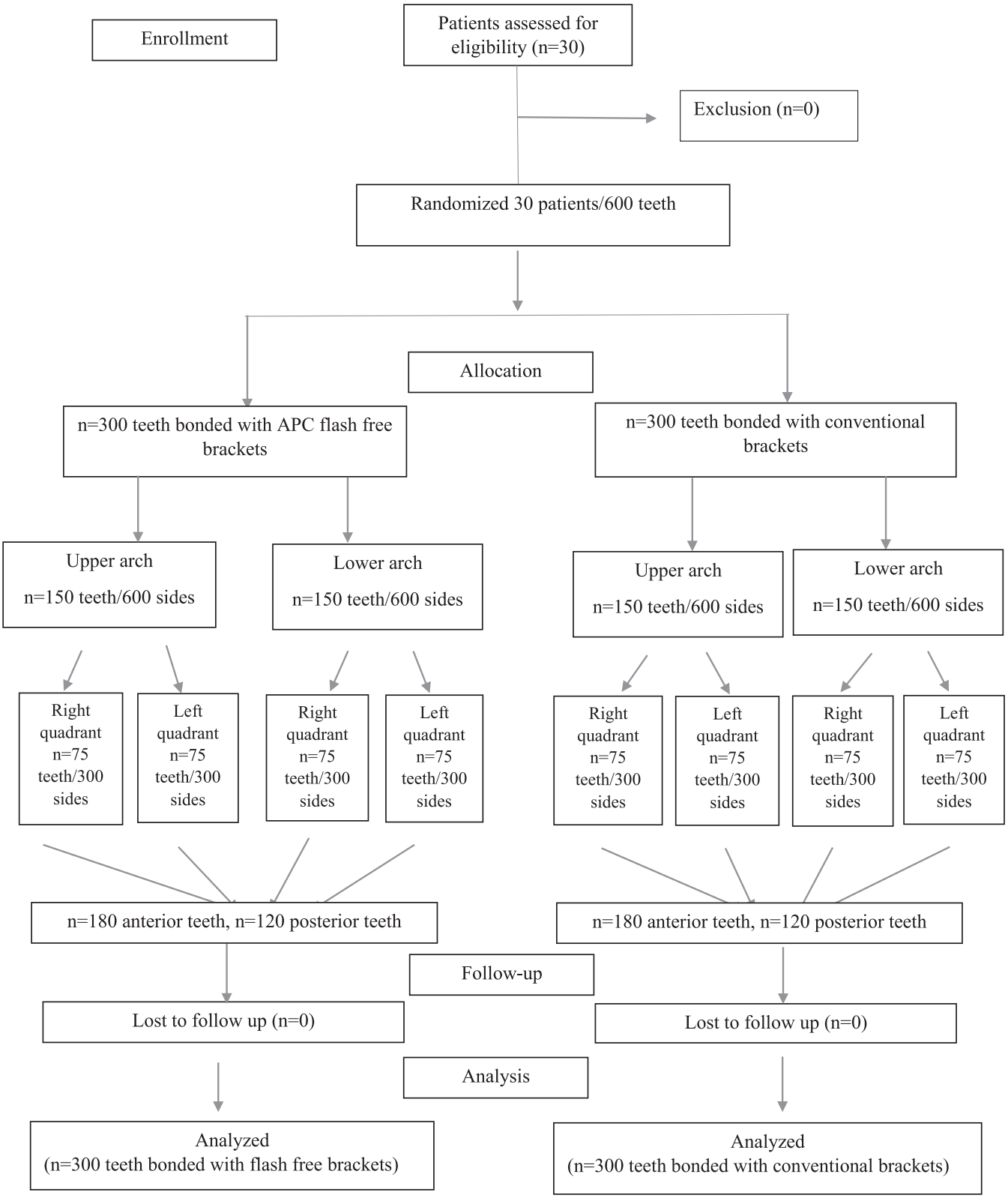

Figure 1. Consort flow chart.

Figure 2. Recording of demineralization measurements.

RESULTS

Demineralization Measurements

The mean values and comparison of differences among time intervals in both groups and between groups within time intervals are shown in Table 1. The lowest mean values were found on the incisal sides, except for the gingival sides of the upper flash-free lateral brackets after 6 months of treatment. However, the highest values were found on almost all the distal sides of the upper and mostly on the mesial sides of the lower brackets.

There were statistically significant decreases on the distal side of the first, and all sides of the conventional second premolar brackets, between T0 and T1 in the upper arch. Additionally, significantly decreased values were found especially on all gingival sides of all upper flash-free brackets except for the central incisor, after bonding. Additionally, the incisal/occlusal sides of all lower brackets, except for conventional central, significantly decreased during this time. In the same manner, there were pronounced decreases on the mesial sides of the lower central brackets in both groups.

On the other hand, the demineralization values were found to be statistically higher on more sides for all conventional brackets compared to flash-free brackets between T1 and T2. At the same time, statistically significant decreases were only found in the incisal sides of conventional upper central brackets.

The demineralization values were statistically decreased, especially on the incisal/occlusal sides of all upper brackets, except for the conventional canine, between T0 and T2. In the conventional group, significantly lower values were also found on the incisal sides of the central and occlusal sides of the premolar brackets in the lower arch between T0 and T2. However, statistically increased values were only found in the gingival sides of the lower first premolar brackets after 6 months.

In the flash-free group, there were statistically pronounced decreases on the incisal/occlusal sides of the lower canine and first premolar brackets at 6 months after bonding. The mean values of the incisal/occlusal sides of all brackets decreased during this time in both groups. Also, these values were increased on the mesial, distal and gingival sides of the lower brackets in both groups after 6 months of treatment.

Intergroup evaluation showed that there were no statistically significant differences in demineralization measurements between all sides of the conventional and flash-free brackets at all the time intervals (Table 1).

Periodontal Measurements

The comparison of clinical periodontal parameters between the groups at three evaluation times (T0, T1, and T2) and changes between times are shown in Table 2. The lowest mean values were found before bonding, and all periodontal parameters were increased at both times in both groups. Although the mean values were higher in the flash-free group one month later, there were no significant differences between the groups. In the conventional group, more significant increases were observed from T0 to T2.

The mean PI values demonstrated only significant differences between T0 and T2 in both groups. The mean GI values of both groups showed significant differences at all the time intervals, with the exception of the T1 and T2 period in the flash-free group. For BOP values, significant differences were found between T1 and T2 and T0 and T2 in both groups.

All periodontal measurements showed significant differences in both groups between T0 and T2. These parameters showed significant differences, with lower mean values in the flash-free group at T2.

Intergroup evaluation showed that there were no significant differences between the groups at all the time intervals for all clinical periodontal parameters as shown in Table 2.

DISCUSSION

Demineralization Measurements

The findings of this study demonstrated that demineralization values decreased after bonding on most sides of the conventional and flash-free brackets. One month later, more pronounced decreased values were observed on the incisal/occlusal sides of the lower brackets in both groups. In a previous study,

Table 1. Comparison of Demineralization Mean Values of Groups at Three Evaluation Times (T0, T1, T2) and Changes Between Times

Tooth-Side	Conventional (C)						Flash-Free (F)						C&F Comparison		
	T0	T1	T2				T0	T1	T2						
	Mean ± SD	Mean ± SD	Mean ± SD	T0-T1	T1-T2	T0-T2	Mean ± SD	Mean ± SD	Mean ± SD	T0-T1	T1-T2	T0-T2	T0-T1	T1-T2	T0-T2
U1-1	4.07 ± 2.03	4.87 ± 2.54	4.80 ± 2.63	ns	ns	ns	4.57 ± 2.03	4.73 ± 2.12	4.57 ± 1.68	ns	ns	ns	ns	ns	ns
U1-2	4.50 ± 2.43	3.50 ± 1.53	3.57 ± 2.73	ns	ns	0.02*	4.23 ± 1.68	3.63 ± 1.88	3.70 ± 1.93	ns	ns	ns	ns	ns	ns
U1-3	3.93 ± 2.29	3.80 ± 1.67	3.93 ± 1.78	ns	ns	ns	5.00 ± 2.0	4.20 ± 1.73	4.23 ± 1.98	ns	ns	ns	ns	ns	ns
U1-4	4.10 ± 2.16	4.23 ± 2.43	2.63 ± 0.93	ns	0.00*	0.00*	4.20 ± 1.37	4.03 ± 2.34	3.13 ± 2.37	ns	ns	0.00*	ns	ns	ns
U2-1	5.70 ± 3.09	4.47 ± 1.87	5.50 ± 2.70	ns	ns	ns	4.67 ± 1.79	5.10 ± 2.43	5.33 ± 2.59	ns	ns	ns	ns	ns	ns
U2-2	4.17 ± 1.98	3.60 ± 1.50	3.70 ± 2.09	ns	ns	ns	4.57 ± 1.94	3.27 ± 1.41	3.47 ± 1.72	0.01*	ns	ns	ns	ns	ns
U2-3	5.00 ± 2.74	4.60 ± 2.43	4.53 ± 2.01	ns	ns	ns	4.80 ± 1.58	4.63 ± 1.59	4.90 ± 1.81	ns	ns	ns	ns	ns	ns
U2-4	4.53 ± 2.19	4.50 ± 2.53	3.33 ± 1.75	ns	ns	0.01*	4.43 ± 1.43	4.43 ± 2.3	3.77 ± 2.51	ns	ns	0.02*	ns	ns	ns
U3-1	5.67 ± 2.96	5.83 ± 2.93	6.73 ± 4.65	ns	ns	ns	5.60 ± 2.75	5.03 ± 2.24	5.63 ± 2.46	ns	ns	ns	ns	ns	ns
U3-2	5.43 ± 2.70	4.60 ± 2.24	5.27 ± 2.97	ns	ns	ns	5.40 ± 2.31	4.20 ± 1.32	4.47 ± 2.00	0.02*	ns	ns	ns	ns	ns
U3-3	5.17 ± 2.60	5.40 ± 2.11	5.93 ± 2.68	ns	ns	ns	4.80 ± 1.75	5.30 ± 1.95	5.73 ± 2.86	ns	ns	ns	ns	ns	ns
U3-4	4.97 ± 2.76	4.77 ± 2.53	3.87 ± 1.28	ns	ns	ns	5.07 ± 2.42	4.67 ± 2.4	3.57 ± 1.25	ns	ns	0.01*	ns	ns	ns
U4-1	7.97 ± 3.13	5.93 ± 2.64	7.23 ± 2.78	0.02*	ns	ns	7.07 ± 2.94	5.03 ± 2.11	6.10 ± 3.09	0.02*	ns	ns	ns	ns	ns
U4-2	5.90 ± 3.07	5.07 ± 2.21	6.07 ± 3.25	ns	ns	ns	6.07 ± 3.02	4.40 ± 1.25	6.20 ± 4.87	0.01*	ns	ns	ns	ns	ns
U4-3	5.77 ± 2.34	5.07 ± 2.32	5.80 ± 2.66	ns	ns	ns	5.87 ± 2.73	5.17 ± 2.49	6.80 ± 3.81	ns	ns	ns	ns	ns	ns
U4-4	5.77 ± 2.78	4.63 ± 2.74	3.70 ± 2.77	ns	ns	0.00*	5.23 ± 2.24	4.60 ± 2.58	4.40 ± 4.39	ns	ns	0.01*	ns	ns	ns
U5-1	8.13 ± 3.36	6.40 ± 2.72	8.13 ± 3.08	0.04*	0.03*[a]	ns	7.80 ± 2.99	5.97 ± 2.34	7.83 ± 2.87	ns	0.01*[a]	ns	ns	ns	ns
U5-2	7.30 ± 3.19	4.90 ± 2.12	6.63 ± 3.23	0.03*	0.04*[a]	ns	7.17 ± 2.65	5.20 ± 2.63	6.63 ± 3.19	0.00*	ns	ns	ns	ns	ns
U5-3	5.93 ± 2.41	4.70 ± 1.37	6.67 ± 3.37	0.04*	ns	ns	6.40 ± 2.33	4.77 ± 2.14	6.13 ± 2.87	0.00*	ns	ns	ns	ns	ns
U5-4	5.70 ± 2.53	3.93 ± 1.57	3.87 ± 1.55	0.01*	ns	0.001*	5.57 ± 2.42	4.43 ± 2.19	4.10 ± 2.78	ns	ns	0.00*	ns	ns	ns
L1-1	5.37 ± 2.19	4.67 ± 2.12	6.33 ± 3.10	ns	0.02*[a]	ns	5.77 ± 2.39	4.70 ± 1.70	6.33 ± 2.92	ns	0.02*[a]	ns	ns	ns	ns
L1-2	5.13 ± 2.78	4.43 ± 2.13	5.27 ± 2.79	ns	ns	ns	3.90 ± 1.63	4.40 ± 2.43	4.93 ± 2.61	ns	ns	ns	ns	ns	ns
L1-3	6.00 ± 1.97	4.87 ± 2.16	6.37 ± 2.47	0.01*	0.00*[a]	ns	5.90 ± 1.97	4.60 ± 1.81	5.93 ± 2.50	0.002*	0.014[a]	ns	ns	ns	ns
L1-4	4.07 ± 1.26	2.90 ± 1.49	3.23 ± 1.65	ns	0.00*[a]	0.00*	3.90 ± 1.83	3.23 ± 1.77	3.87 ± 2.98	0.02	ns	ns	ns	ns	ns
L2-1	5.47 ± 2.47	4.73 ± 2.48	6.30 ± 2.68	ns	0.02*[a]	ns	5.57 ± 2.54	4.97 ± 2.19	6.37 ± 2.88	ns	ns	ns	ns	ns	ns
L2-2	4.33 ± 1.71	4.73 ± 2.18	5.23 ± 2.34	ns	ns	ns	4.97 ± 2.14	4.37 ± 1.54	5.33 ± 3.13	ns	ns	ns	ns	ns	ns
L2-3	5.70 ± 2.38	5.17 ± 2.05	7.73 ± 7.24	ns	ns	ns	5.70 ± 2.07	5.00 ± 1.60	6.57 ± 3.37	ns	ns	ns	ns	ns	ns
L2-4	4.03 ± 1.19	3.20 ± 1.85	3.80 ± 1.71	0.02*	ns	ns	3.90 ± 1.54	3.53 ± 2.00	3.80 ± 2.37	0.03*	ns	ns	ns	ns	ns
L3-1	4.57 ± 1.98	4.77 ± 2.25	5.83 ± 2.91	ns	0.04*[a]	ns	5.13 ± 2.36	5.67 ± 2.47	5.93 ± 2.79	ns	ns	ns	ns	ns	ns
L3-2	4.93 ± 2.36	4.00 ± 1.62	6.30 ± 6.68	ns	0.03*[a]	ns	4.27 ± 1.98	4.40 ± 2.34	4.80 ± 2.19	ns	ns	ns	ns	ns	ns
L3-3	5.07 ± 1.96	4.57 ± 1.89	5.90 ± 3.10	ns	ns	ns	5.20 ± 2.25	5.23 ± 2.06	5.93 ± 2.95	ns	ns	ns	ns	ns	ns
L3-4	4.13 ± 1.33	3.40 ± 0.81	3.97 ± 2.27	0.03*	ns	ns	4.13 ± 1.43	3.73 ± 2.48	3.30 ± 1.09	0.02*	ns	0.02*	ns	ns	ns
L4-1	4.97 ± 2.06	4.53 ± 1.43	5.30 ± 1.86	ns	ns	ns	5.23 ± 1.83	5.13 ± 2.01	6.03 ± 3.01	ns	ns	ns	ns	ns	ns
L4-2	4.97 ± 2.41	4.83 ± 2.17	6.13 ± 2.60	ns	ns	0.02*[a]	5.17 ± 2.35	5.37 ± 2.09	5.93 ± 2.32	ns	ns	ns	ns	ns	ns
L4-3	4.90 ± 2.23	4.43 ± 1.38	6.20 ± 4.66	ns	0.03*[a]	ns	4.80 ± 1.75	4.63 ± 1.79	6.07 ± 4.26	ns	ns	ns	ns	ns	ns
L4-4	4.27 ± 1.89	2.87 ± 1.36	3.20 ± 1.30	0.00*	ns	0.02*	4.10 ± 1.73	3.07 ± 1.72	3.03 ± 1.38	0.001*	ns	0.001*	ns	ns	ns
L5-1	5.27 ± 2.65	4.90 ± 1.71	5.67 ± 4.60	ns	ns	ns	5.63 ± 2.51	5.03 ± 2.13	6.13 ± 3.49	ns	ns	ns	ns	ns	ns
L5-2	6.30 ± 2.85	5.07 ± 2.33	7.03 ± 2.99	ns	0.00*[a]	ns	6.77 ± 2.43	5.23 ± 2.56	7.27 ± 3.83	0.02*	0.03*[a]	ns	ns	ns	ns
L5-3	5.60 ± 3.09	4.30 ± 1.29	5.63 ± 2.91	ns	ns	ns	5.10 ± 2.06	4.47 ± 1.85	5.70 ± 3.64	ns	ns	ns	ns	ns	ns
L5-4	4.47 ± 2.45	3.03 ± 0.96	3.13 ± 1.46	0.01*	ns	0.01*	3.83 ± 1.56	3.10 ± 1.79	3.30 ± 1.70	0.04*	ns	ns	ns	ns	ns

U: Upper; L: Lower.
First number indicates tooth number.
Second number indicates bracket sides 1: Distal; 2: Gingival; 3: Mesial; 4: Incisal/Occlusal.
SD: Standard deviation; [a] demonstrates statistically significant increase; ns: non-significant.
* $P < .05$.

Table 2. Comparison of Periodontal Parameters of Groups at Three Evaluation Times (T0, T1, T2) and Changes Between Times

	Groups	T0	T1	T2			
		Mean ± SD	Mean ± SD	Mean ± SD	T0-T1	T1-T2	T0-T2
PI	Conventional	0.23 ± 0.1	0.27 ± 0.15	0.35 ± 0.12	ns	ns	0.002*
	Flash-Free	0.22 ± 0.1	0.28 ± 0.14	0.34 ± 0.12	ns	ns	0.001*
	P	.771	.7	.767			
GI	Conventional	0.39 ± 0.13	0.5 ± 0.11	0.56 ± 0.09	0.0001*	0.0001*	0.0001*
	Flash-Free	0.37 ± 0.13	0.51 ± 0.09	0.55 ± 0.09	0.0001*	ns	0.0001*
	P	.541	.61	.775			
BOP	Conventional	13.89 ± 12.05	18.33 ± 19.38	35.56 ± 16.51	ns	0.0001*	0.0001*
	Flash-Free	13.33 ± 10.63	21.94 ± 19.14	34.72 ± 18.84	ns	0.0001*	0.0001*
	P	.958	.355	.856			

SD: Standard deviation; ns: non-significant.
* $P < .05$.

Sukontapatipark et al.[17] stated that the rough surfaces and gaps between the composite and enamel surface may increase demineralization caused by plaque accumulation. Hence, this situation can be explained by the easier removal of excessive adhesive from the sides of conventional brackets. Changes on all sides of the premolar brackets in both groups were observed as remineralization after bonding; the one exception was the gingival side of the lower first premolar flash-free brackets. Interestingly, these decreased values may have resulted from incorrect measurements, especially on the gingival side, because of inflammation and positioning of brackets near the gingiva. In relation to this, Walsh[18] emphasized that the requirement for reliable detection of demineralization was that saliva, stains and dental plaque must be removed from the tooth surfaces before readings of enamel are taken.

As time progressed, the demineralization occurred again on almost all sides, except the occlusal sides of the upper premolar brackets in both groups from the first to the sixth month. In a study examining the incidence of WSLs during treatment with regard to the location of teeth regardless of bracket sides, it was reported that demineralization increased rapidly in the upper and lower premolar teeth.[11] These increases in the posterior regions could be attributed to the lack of effective brushing due to the position of the teeth. The substantially increased demineralization values were observed on more sides of the conventional bracket group in both arches. This may have been due to the claim that the nonwoven mat soaked with resin under the flash-free brackets could fill the gap between the bracket edges and tooth surface and prevent plaque adhesion by providing a smooth transition.[2]

It was found that the demineralization values on the incisal/occlusal sides of all brackets decreased after 6 months of treatment in both groups. On the other hand, Khalaf[13] stated that the most affected surfaces from WSLs were the gingival areas of the upper and lower teeth. Previous studies revealed that the bonding of orthodontic brackets led to demineralization on the gingival aspects of the mandibular canines and premolars.[7,10] Consistent with these findings, higher demineralization values were found on the gingival sides of the lower canine and second premolar brackets in both groups after 6 months of treatment. Additionally, the mesial and distal sides of other lower brackets were vulnerable to demineralization during the same time interval. This situation can be explained by the fact that the area between the bracket edge and gingival margin was narrower on all sides of the mandibular teeth, making the cleaning of these areas more difficult.

When the mean demineralization values of the upper brackets were examined, it was seen that the distal sides of the lateral brackets had higher values within the incisors of both groups 6 months after treatment. The reason why this tooth was especially emphasized was that many studies explained that the maxillary lateral incisor was the most affected tooth from WSLs associated with fixed treatment.[7,8,12,13,19,20] In particular, several authors reported that the most affected area was the labiogingival region of the lateral incisor tooth.[9,10] Conflicting results relating to the maxillary lateral were found in this study. This may have been due to the use of flash-free brackets, adhesive type, or different assessment methods used in previous studies. Most of the studies that found a high rate of demineralization in the maxillary lateral incisor were those with a longer follow-up period than the current study.[8,12,19,20] Therefore, this tooth may be more at risk in prolonged treatments. The results showed that the demineralization values of the distal and mesial sides of upper brackets commonly increased from anterior to posterior after 6 months of treatment. However, these changes in the form of increments were not observed in the mandibular teeth. The findings supported the results of Chapman et al.,[12] who reported that demineralization increased in the upper arch toward the posterior teeth. In contrast, Gorelick et al.[8] reported that the least affected area was the maxillary posterior region. In the current study, higher demineralization values in the posterior teeth may have been associated with better oral hygiene achieved for the maxillary anterior region.

Periodontal Measurements

The occurrence of WSLs at 6 months after fixed orthodontic treatment demonstrated that demineralization can rapidly become a concern with fixed appliances when oral hygiene is poor.[20] Therefore, the periodontal health of patients was also evaluated in addition to demineralization in this study. Although all patients received routine oral hygiene education, all parameters showed significant differences after 6 months of treatment in both groups. However, the mean values were higher in the conventional group. These results were consistent with the results of a recent systematic review that concluded a moderate relationship between conventional orthodontic brackets irrespective of bracket material and periodontal status.[21]

When the results of this study were evaluated, only gingival index values among all three parameters were increased significantly for both groups between T0 and T1. Gingival inflammation, mild changes in plaque accumulation and bleeding were observed at one

month after the beginning of treatment. This showed that the patients were in the process of getting used to their new brackets and brushing their teeth as described. Since the bracket positions in the posterior regions were close to the gingiva, which caused gingival irritation, the gingival inflammatory changes were not supported by other periodontal parameters.

According to the findings, gingival inflammation and bleeding values increased in the conventional group between the first and sixth months. The absence of plaque may have been due to more careful brushing of the patients before coming to the control session. For this reason, the occurrence of plaque was marked as nonplaque during the evaluation. At this time interval, only the bleeding scores were found to be increased among all parameters in the flash-free group. These changes may have been the result of traumatic circulation of periodontal probes in the gingival pocket and consequently incorrect scoring.

After 6 months of treatment, plaque accumulation and gingival inflammation increased in both groups, and these gingival inflammatory changes demonstrated that the patients' oral hygiene motivation started to decline. In the literature, there are many studies that support the 6-month results of the current study.[22,23]

One limitation was that blinding could not be achieved due to the conditions of the study. Additionally, the findings could not be discussed in detail due to the lack of studies in the literature regarding bracket sides and demineralization. Hence, further studies are necessary for a better understanding of this clinical situation.

According to the data obtained from this study, the null hypothesis that there were no significant differences in the demineralization and periodontal parameters of patients treated with flash-free and conventional brackets could not be rejected.

CONCLUSIONS

- The least affected areas were the incisal sides of conventional and adhesive flash-free brackets. The mesial and distal sides of the brackets were susceptible to demineralization in both groups. In patients undergoing fixed orthodontic treatment, the effects of flash-free and conventional brackets on enamel demineralization and periodontal health did not differ from each other.

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