Original Article

Comparison of Microleakage under Rebonded Stainless Steel Orthodontic Brackets Using Two Methods of Adhesive Removal: Sandblast and Laser

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Abstract
Objectives: Debonding is a common occurrence in orthodontic treatment and a considerable number of orthodontists prefer to rebond the detached brackets because of economic issues. The aim of this study was to compare the microleakage beneath rebonded stainless steel brackets using two methods of adhesive removal namely sandblast and laser.
Materials and Methods: Sixty human premolar teeth were randomly divided into three groups. Following bonding the brackets, group 1 served as the control group. Brackets in groups 2 and 3 were debonded, and adhesive removal from the bracket bases was done by means of sandblasting and Er-YAG laser, respectively. After rebonding, teeth in each group were stained with 2% methylene blue for 24 hours, sectioned and examined under a stereomicroscope. Marginal microleakage at the adhesive-enamel and bracket-adhesive interfaces in the occlusal and gingival margins was determined. Statistical analysis was done using the Kruskal-Wallis test.
Results: Comparison of the microleakage scores among the three groups revealed no statistically significant difference (P > 0.05). At the enamel-adhesive interface, the gingival margins in all groups showed higher microleakage while in the adhesive-bracket interface, the occlusal margin exhibited greater microleakage.
Conclusion: Er-YAG laser irradiation and sandblasting for adhesive removal from the debonded brackets yielded clinically acceptable microleakage scores.
Key words: Dental leakage; Er-YAG lasers; Orthodontic brackets
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INTRODUCTION

Debonding is a common occurrence in orthodontic treatment [1,2]. Despite the improvements in the quality of adhesive materials, the prevalence of bracket detachment is still more than 5-7% and rebonding of the detached brackets is preferred by a large number of orthodontists [3,4]. Therefore, obtaining a reliable adhesive bond between tooth enamel and orthodontic bracket is essential [5].

Economical issues are also important; the cost factor is reduced if the debonded bracket can be used again [6].

Regarding the shear bond strength of rebonded brackets, literature reports inconsistent findings. Some studies report lower bond strength, while others report comparable or higher bond strength values [7-11]. Various adhesive clean-up methods have been reported in the literature, among them sandblasting and Er:YAG laser irradiation have been shown to provide rebond strength comparable to that of new brackets.

Using new brackets for rebonding has shown reduction of 20 to 40% in bond strength in different studies, based on the methods of bonding [12,13]. Microleakage allows for the passage of oral fluids and bacteria and thus white spot lesions may form under the bracket surface area [14-16]. In addition, when rebonding brackets, the bracket bases are often not intact [4], and the degree up to which we could clean the base from residual adhesives affects the microleakage. This may be attributed to the fact that when the bracket base is altered by the method of adhesive cleaning following debonding, the composite adaptation to the base would be different compared to what we have in new bracket bases. In the process of adhesive clean up, methods used can alter the bracket base properties such as its mesh form [2], which has been documented in previous researches by scanning electron microscope examination [4]. Therefore we hypothesized that different methods of adhesive removal may result in different microlaekage values. Since higher microleakage score can gradually lead to white spot formation and subsequent esthetic problems, we believed that the comparison of microleakage between these two methods of adhesive removal and a control group was worth studying.

James et al. reported that microleakage around orthodontic brackets increased the risk of demineralization [15]. Arhun et al. found that microleakage at the adhesive-bracket interface with metal brackets was more than with ceramic brackets, which may result in lower shear bond strength and formation of white spot lesions [17].

Arikan et al. assessed the microleakage beneath brackets with different light curing units and bracket types and concluded that ceramic brackets cured with diode units had the lowest microleakage scores [18].

So far, to our knowledge, some studies have assessed bond strength of rebonded brackets but the literature is scarce on the microleakage of rebonded brackets.

Considering the results of previous studies in support of Er:YAG laser irradiation and sandblasting as clinically acceptable methods of adhesive removal for bracket rebonding [19-21], the aim of this study was to compare the in vitro microleakage of metal brackets rebonded using Er:YAG laser and sandblasting.

MATERIALS AND METHODS

Sixty fresh human premolar teeth extracted for orthodontic purposes were used in this study. The teeth were free of caries, cracks or gross irregularities of the enamel structure. The teeth were stored in distilled water at room temperature until the experiment.

Before bonding, the teeth were polished with fluoride-free pumice powder. The teeth were randomly divided into three groups of 20 namely the control group (C), laser group (L), and sandblast group (S).

Bonding procedure:

Premolar metal edgewise brackets (MBT, American Orthodontics, USA) were used. Etching was done with 37% phosphoric acid gel (Ormco, Italy) applied to the buccal surface of teeth for 30 seconds. The teeth were then sprayed with water for 20 seconds and dried with oil-free air spray for 20 seconds until the buccal surfaces of the teeth appeared frosty. A thin coat of light cure primer (Ormco, Italy) was applied to the etched surfaces and the base of brackets using a microbrush.

The light cure adhesive (Greenglue, Italy) was applied to each bracket base.

The brackets were placed with tweezers with optimum pressure and then cured with quartz tungsten halogen light curing unit (Faraz Dentin, Iran) for 40 seconds (10 seconds for each bracket side). One operator performed all the procedures.

Debonding procedure:

Debonding was done with a bracket removing plier (Dentaurum, Germany) in L group and S group with caution not to distort the brackets. After removal of brackets, the remnant adhesive on enamel surfaces was removed with tungsten carbide bur until no composite was detectable by the naked eye under unit lamp.

Adhesive removal procedure:

Group L: Adhesive on the back of the brackets was removed with Er:YAG laser device (Fontana, 1210 Ljubljana, Slovenia) at a wavelength of 2,940 nm, spot size of 0.9 mm and RO2-C headpiece. The laser operated in pulse mode (medium short pulse) at a distance of 5 mm perpendicular to the bracket bases. The mean power output was 5.5 W and the laser was used at 225 mJ and 15 Hz for 10 seconds with air and water coolant [17].

Group S: Sandblasting was done using aluminum oxide abrasion unit model II (Danville Engineering Co, USA) using 50–µm aluminum oxide abrasive powder at a distance of 3mm from bracket base for 5 seconds [23], with the nozzle tip sweeping in a mesiodistal direction and the base of each debonded bracket was etched under 50 PSI pressure [24]. Micro etching was stopped when the metal base appeared roughened and no resin remnants were detectable on visual inspection [25].

Rebonding procedure:

Teeth conditioning with 37% phosphoric acid was done as mentioned earlier, except no rubber cup prophylaxis of the enamel surfaces was performed prior to the etching process. Rebonding of the recycled brackets was done as initial bonding in groups L and S.

Microleakage evaluation:

Before dye penetration, the apex of each sample was sealed with sticky wax, then nail varnish was applied to the entire surfaces of the teeth except for 1 millimeter around the brackets. After that, the teeth were immersed in 2% methylene blue solution for 24 hours at room temperature. After being removed from the solution, samples were rinsed under tap water and brushed to remove the superficial dye; then teeth were mounted vertically in acrylic blocks.

Two parallel longitudinal sections were made with a diamond disk in a sectioning machine (safaei, Iran) in buccolingual direction.

Evaluation of dye penetration was done under a stereomicroscope (×20 magnification) (SZ 40, Olympus, Tokyo, Japan). Dye penetration at both gingival and occlusal margins of the brackets at the enamel-adhesive and the adhesive-bracket interfaces in each section was measured using an electronic digital gauge (Shoka Golf, Japan) and the data were recorded to the nearest 0.05 mm value.

Statistical analysis

Both the adhesive–bracket and the enamel–adhesive interfaces were evaluated at the gingival and occlusal margins in the three groups. Statistical analysis was done using SPSS version 17. Since the Kolmogorov- Smirnoff test showed that the data distribution was not normal, a non- parametric test (Kruskal- Wallis) was used. Statistical significance was set at $P < 0.05$.

RESULTS

The results of Kruskal- Wallis test revealed no significant differences in microleakage scores among the groups ($P=0.157$). Thus, no more tests were done for multiple comparisons.

Microleakage was observed in all groups. Comparison of the microleakage scores between the occlusal and gingival margins at the enamel – adhesive and adhesive – bracket interfaces is shown in Table 1.

In all groups, the gingival margin of enamel – adhesive interfaces showed higher microleakage while at the adhesive-bracket interfaces, the occlusal margin exhibited higher microleakage; however, the differences were not statistically significant.

Comparisons among the three groups at the occlusal margin, gingival margin and both showed no statistically significant difference.

The mean microleakage scores in the C group, S group and L group were 0.343, 0.502 and 0.496, respectively (Table 2).

Thus, the mean microleakage score was the highest in S group and the lowest in C group; however the differences were not statistically significant.

DISCUSSION

Today, a large number of orthodontists prefer to rebond the debonded brackets. According to the results of the current study, sandblasting and Er-YAG laser for adhesive removal from the back of debonded brackets can affect the microleakage scores at the occlusal and gingival margins of enamel-adhesive and adhesive-bracket interfaces; although the difference was not statistically significant. The overall microleakage score was the highest in S group followed by L group and C group, respectively. In the bracket –adhesive interfaces, the microleakage scores were greater in the occlusal margin, while the gingival margin at the enamel-adhesive interface had higher

Table 1. Comparison of the microleakage scores between the occlusal and gingival margins at the enamel-adhesive and adhesive-bracket interfaces.

Interface	Groups	N	Occlusal Mean	Occlusal SD	Occlusal Median	Gingival Mean	Gingival SD	Gingival Median	P value	
Enamel – adhesive inter face	1. Control	30	0.243	0.252	0.190	0.320	0.316	0.235	0.101	NS
	2. Sandblast	29	0.494	0.433	0.357	0.573	0.453	0.430	0.689	NS
	3. Laser	31	0.362	0.269	0.310	0.589	0.579	0.400	0.104	NS
Adhesive –bracket interface	1. Control	30	0.598	0.475	0.505	0.427	0.373	0.400	0.079	NS
	2. Sandblast	29	0.555	0.421	0.540	0.416	0.368	0.285	0.136	NS
	3. Laser	31	0.575	0.478	0.534	0.396	0.435	0.288	0.092	NS

N indicates sample size, SD: standard deviation, NS: not significant (P <0.05 was significant)

Table 2. Comparison of total microleakage scores

Group	Occlusal (enamel adhesive +adhesive bracket) Mean	SD	Gingival (enamel adhesive +adhesive bracket) Mean	SD	Total Mean	SD	P value	
Control	0.341	0.255	0.347	0.595	0.343	0.26	0.247	NS
Sandblast	0.532	0.339	0.468	0.541	0.502	0.247	0.552	NS
Laser	0.489	0.327	0.446	0.821	0.467	0.310	0.496	NS

SD = standard deviation, NS: not significant (P< 0.05 was significant)

microleakage scores.
Since we used dual contour brackets, it can be claimed that adhesive thickness was uniformly even at the occlusal and gingival levels. Therefore, different surface curvatures could not influence the microleakage scores. Yassaei et al. investigated the shear bond strength of brackets recycled with different methods of resin removal (including sandblast and Er:YAG laser) and concluded that sandblasting and Er:YAG laser were efficient in-office methods of reconditioning debonded brackets, with minimal damage to the bracket base [19].
Ishida et al. conducted a study on shear bond strength of rebonded brackets in which adhesive remnants of the debonded brackets were removed with different methods such as sandblast and Er,Cr:YSGG laser, and they found that using sandblast and Er,Cr:YSGG laser for adhesive removal can certainly enhance the use of recycled orthodontic brackets [20]. According to previous studies, sandblast and Er laser are suitable methods of resin removal for rebonding brackets [19, 20, 21].
With respect to the critical role of microleakage in white spot formation and reducing the shear bond strength, and the importance of rebonding in clinical orthodontics, we decided to conduct the present study to compare the microleakage beneath the base of brackets rebonded after sandblasting and Er: YAG laser irradiation. Yagci et al. found that when direct and indirect bonding methods were used at the enamel–adhesive and adhesive–bracket interfaces, microleakage scores at the gingival margins were greater than at the occlusal margins [26]. Arhun et al. observed that microleakage scores at the incisal and gingival margins of brackets showed significant differences, implying increased microleakage at the gingival margin. They attributed these differences to the curvature of the tooth morphology, which can result in thicker composite at the gingival margin [17].
Uysal et al. [28] and Ulker et al. [27] had the same findings as those of Arhun et al. But the interpretation was different. They observed that lower or no microleakage scores at the occlusal compared to the gingival margin can be related to the curing method; because of lighting from the occlusal direction.
Ulker et al. investigated the microleakage under orthodontic brackets using high intensity curing lights and concluded that gingival margins in all groups had higher microleakage scores compared to occlusal margins at both adhesive interfaces [27]. Uysal et al. observed the microleakage under metallic and ceramic brackets bonded with orthodontic self-etching primer systems and found that gingival margins in all groups had higher microleakage scores in comparison with occlusal margins for both adhesive interfaces; and enamel-adhesive interfaces exhibited more microleakage than did the adhesive-bracket interfaces [28]. Literature reports contradictory results regarding the bond strength of rebonded brackets; some researchers concluded that reusing the brackets did not affect the bond strength significantly, while others concluded that rebonding led to lower bond strength.
To our knowledge, some studies have assessed bond strength of rebonded brackets but no literature has reported the effect of rebonding on microleakage.

CONCLUSION

Comparison of the microleakage scores among the three groups showed that they had no statistically significant difference ($P > 0.05$), although the mean microleakage scores were the highest in the sandblast group and the lowest in the control group.
Er-YAG laser irradiation and sandblasting for removing the adhesive from the back of the debonded brackets prior to rebonding had no significant effect on microleakage scores; therefor the microleakage scores were clinically acceptable using these methods prior to rebonding the brackets. Microleakage score was higher in bracket –adhesive interfaces in all groups except for the sandblast group.

Microleakage score was higher in gingival margin at the enamel-adhesive interfaces and in occlusal margin at the adhesive–bracket interfaces.

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