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Original Article

Comparison of the Shear Bond Strength of Treated and Untreated Brackets on Treated and Untreated Enamel Surfaces in Rebonding

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Abstract

Aim and Objective: This study aimed to compare the shear bond strength (SBS) of treated and untreated brackets on treated and untreated enamel surfaces in rebonding. The null hypothesis was that there was no difference between the SBS of the treated and untreated rebonded brackets on treated and untreated enamel surfaces. **Materials and Methods:** Fifty extracted premolars were bonded by the same conventional bonding method and then debonded, and the SBS of each tooth was recorded. The debonded brackets and teeth were divided into two equal groups. In the first group, the debonded brackets were recycled by direct flaming followed by alumina oxide sandblasting, and the teeth were treated with a tungsten carbide bur applied with a low-speed hand piece. In the second group, neither the teeth surfaces nor the bracket bases were treated. Rebonding was performed followed by debonding, and the SBS of each tooth was recorded again. **Results:** Both rebonded bracket groups showed lower SBS results than that of the first debonding tests. A statistically significant difference was found within the untreated bracket groups between the first and second debonding test ($P < 0.001$). **Conclusion:** The rebonding of treated enamel surfaces and treated bracket bases showed higher SBS values compared to the untreated ones. The null hypothesis was rejected.

Keywords: *Bracket base, debonding, enamel surface, rebonding, shear bond strength*

Introduction

Direct bonding of orthodontic brackets has been an accepted clinical procedure starting from the late 1970s. Since then, bracket failure has been a major problem of orthodontists.[1] There are various clinical reasons for the bond failure of a bracket such as sudden force applied by patients, poor bonding technique, tooth type, bracket type, design, and occlusal forces.[2] To solve this problem, the orthodontist may treat the used bracket and rebond it, use a new bracket, or sometimes place a band instead.[3]

Although an undesirable situation, the rebonding of a bracket is frequently encountered during orthodontic treatment.[4]

Several procedures have been described in the literature for the reconditioning of debonded enamel surfaces and bracket bases.[5]

Considering the economic reasons, the debonded brackets are rebonded after the removal of the residual adhesive from the bases by several methods, including sandblasting, mechanical grinding, adhesive burning, and lasers.[6]

Conversely, various methods such as the use of scalers or band-removing pliers, tungsten carbide burs, sandblasting, and a variety of lasers have been suggested for the reconditioning of enamel surfaces in previous studies.[6,7]

Treating a debonded bracket and rebonding it takes up additional time for both the clinician and the patient and also lengthens the total treatment time.[1]

The aim of the present study was to evaluate the shear bond strength (SBS) of the treated and untreated rebonded bracket bases and enamel surfaces and determine the use of debonded brackets, directly without any preparation, in the untreated debonded enamel surfaces, leading to a time- and cost-effective procedure. Therefore, the null hypothesis of this study was that there were no differences between the SBS values

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of the treated and untreated rebonded bracket bases and enamel surfaces.

Materials and Methods

The Ethics Committee of Istanbul Medipol University approved the study with the ethical number: 23/06/2017-222.

Fifty healthy premolars extracted for orthodontic purposes were molded in plastic boxes perpendicular to the self-curing acrylic. The teeth without any enamel cracks or fractures, caries, and enamel anomalies were included in this study. Each tooth was recorded by a numbered to compare the primary and secondary SBS. For primary bonding, 50 teeth were bonded with the same type of metal brackets (3M Gemini Roth, 3M, Gemini Roth, Monrovia, Calif) [Figure 1] using the conventional bonding method, which involved 15-s acid etching [37% phosphoric acid (3M Espe Scotchbond Multi-Purpose Etchant; 3M ESPE, Seefeld, Germany)], 15-s washing, 15-s air drying, and bonding with 3M Transbond XT, Monrovia, Calif [Figure 2] with the application 15 s of light. The bonding area was approximately in the middle of the mesiodistally third and occlusogingivally third of the labial surface of the teeth.

Subsequently, all brackets were debonded [Figure 3] with a shear test machine (Universal Testing Machine Shimadzu Autograph AGS-X, Kyoto, Japan, 2014) [Figure 4] with a speed of 1 mm/min. The load needed to debond the brackets was expressed in Newton/millimeter^2 (N/mm^2). This value was converted to megapascals (MPa), and descriptive statistics were determined. Moreover, the shear rebond strength (SRS) values of each tooth were determined and recorded.

For secondary bonding, the teeth were divided into two equal experimental groups of 25.

In the first group, the adhesive remnants on the bases of the brackets were removed by direct flaming by gas torch, followed by sandblasting with a 50-μm aluminum oxide

Figure 1: Teeth molded in plastic boxes with separate labelling for each group

Figure 2: Bonding materials used for the study

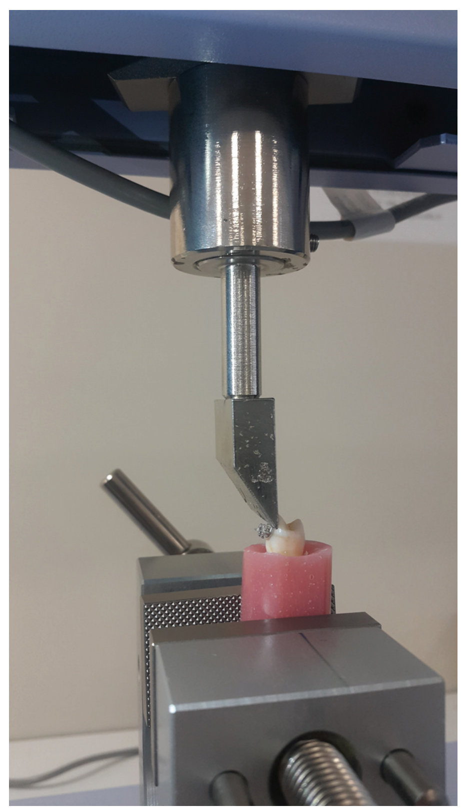

Figure 3: A molded sample in universal test machine

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Figure 4: Universal testing machine

Figure 5: Airsonic mini sandblaster

particle stream (Airsonic Mini Sandblaster; Hager & Werken, Duisburg, Germany) [Figure 5].

Composite remnants on the surfaces of the debonded teeth in the first group were removed by tungsten carbide burs used with a low-speed hand piece at a speed of 25,000 rpm without water.

In the second group, neither the teeth surfaces nor the bracket bases were treated. In both the recycled and untreated groups, all brackets of all teeth were bonded to their respective teeth again by the same conventional bonding methods. Then, all brackets were debonded again with the same shear test machine, and the SBS of each tooth was determined and recorded again.

Figure 6: Stereomicroscope

After the first and second debonding tests, the adhesive remnant index (ARI) scoring[8] was used to evaluate the remaining adhesive on the teeth and evaluated using a stereomicroscope (Leica MZ 12, Leica Microsystems, Bensheim, Germany) [Figure 6]. The ARI scoring was performed according to the amount of remaining adhesive on the tooth (0 = no adhesive, 1 = less than half of the adhesive, 2 = more than half of the adhesive, and 3 = all adhesive).

The flowchart of the study is shown in Figure 7.

Statistical analysis

Minitab 17 statistical software program was used to evaluate the data (Minitab Inc., State College, Pennsylvania, USA). Power analysis performed using software (G×Power Version 3.1.9; Franz Universitat Kiel, Kiel, Germany), and sample size was calculated as $n = 16$ in each group to give 80% power.

The convenience of the normal distribution of permanent variables was investigated using the Anderson–Darling test. The unpaired *t*-test was used to evaluate the normally distributed data. A paired sample *t*-test was used to evaluate the differences within groups. The Weibull analysis was performed for all groups. The results were presented as median levels with minimum and maximum values. The level of significance was set at $P < 0.05$.

Results

The SBS results of the groups with the mean and standard deviation are shown in Table 1. Mean shear rebond strength

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was higher in the teeth prepared with the conventional technique than the untreated ones. Both rebonded bracket groups (secondary debonding groups) showed lower SBS results than the first debonding tests (primary debonding). A statistically significant difference was found within the untreated bracket groups between the first and second debonding tests ($P < 0.001$). Table 2 presents the results of the Weibull analysis. The Weibull modulus of the groups was consistent with the SBS results. The Weibull modulus of Group 1 was higher than that of Group 2 according to results of the first and second debonding tests.

Adhesive remnant index (ARI) scores

Median values of the ARI scores are shown in Table 3. The differences between the groups in the ARI scores were compared by using the Kruskal–Wallis test. There was no significant difference between the groups in the first debonding test, but a significant difference was found between the groups in the second debonding test in the ARI scores ($P < 0.001$). Group 1 showed a higher ARI score than Group 2 in the secondary test.

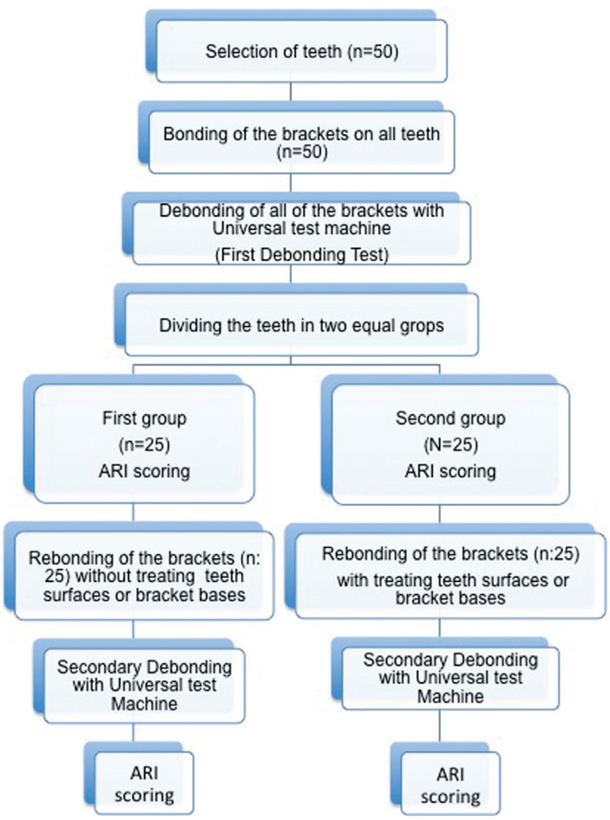

Figure 7: Flowchart of the study

Table 1: Shear bond strength values of the groups with mean and standard deviations

	First debonding test	Second debonding test	P
Group 1	8.4±4.1	6.7±4.8	0.052
Group 2	8.3±3.9	4.7±2.4	<0.001
P	0.048	<0.001	

Discussion

Bonding failure of brackets frequently occurs in daily orthodontic practice, lengthening the treatment time and increasing the treatment costs.[9]

To gain a strong and reliable adhesion between the tooth enamel and brackets is the main goal of orthodontic practice. The optimal SBS of orthodontic brackets should be both adequate to keep them in place during the treatment and allow them to separate easily from the tooth surface at the end of the treatment.[10,11] Reynolds[12] reported the needed minimum clinical SBS for brackets as 5.9 to 8.7 MPa. In this study, the primary debonding test results in Groups 1 and 2 showed sufficient mean SBS values according to a previous study of Reynolds.[12]

There are many studies evaluating the SBS of intact and rebonded enamel surfaces that report controversial findings in previous studies.[13-15] Another study reported that there were no significant differences between the SBS of intact and rebonded surfaces. Eminkahyagil *et al.*[7] and Montasser *et al.*[4] reported that the SBS of rebonded surfaces was higher than that of the intact enamel surfaces. It was reported that the SBS of rebonded surfaces was lower than that of intact enamel surfaces in previous reports.[1,16] The second debonding test results in this study showed lower SBS results than that of the first debonding test results; therefore, this finding does not corroborate the previous reports.[1,16] Furthermore, there was no significant difference in the values of first and second debonding tests in Group 1, but the decrease of SBS in the first and second debonding test values in Group 2 was statistically significant. The

Table 2: The results of Weibull analysis

		Weibull modulus
Group 1	First debonding test	2.292
	Second debonding test	1.841
Group 2	First debonding test	2.290
	Second debonding test	1.836

Table 3: ARI scores of the adhesives according to Kruskal–Wallis test

	N	ARI scores (median)First debonding test	ARI scores (median)Second debonding test	*P*-value
Group 1	25	2	2	0.062
Group 2	25	2	1	<0.001
		0.059	<0.001	

$^*P < 0.001$.

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conventional method (Group 1) was superior to no treatment (Group 2). The Weibull modulus values and the ARI scores in this study were consistent with the SBS results. The rebonding of the untreated bracket base and tooth surface showed lower values in all these parameters.

The new bond failure rate following rebonding has been reported as 10% to 25% in various studies.[17] It was reported that the SBS of rebonding could be 33% less than the primary bonding strength.[1] The decrease of SBS in this study was inconsistent with previous studies. This study showed a 20.2% decrease in Group 1, which was inconsistent with a previous report.[17] In Group 2, the decrease of mean SBS values was found as a 43.3% decrease in Group 2. The mean SBS values decreased more dramatically in Group 2.

There are several methods such as the use of scalers or bond-removing pliers, tungsten carbide burs, sandblasting, and a variety of lasers, which are suggested for the reconditioning of enamel surfaces in the literature.[1,4,6,7] In our study, for reconditioning of the debonded enamel surfaces in the treated examples group, we used tungsten carbide burs before conventional acid etching with phosphoric acid. The purpose of using carbide burs was to mimic routine clinical conditions.

Kilponen *et al.*[10] reported that a small amount of enamel removal from the debonded enamel surface before rebonding refreshes the surface for rebonding and increases the bond strength.

Bishara *et al.*[16] and Bishara *et al.*[1] reported that the residual adhesive on the debonded enamel surface could decrease the rebonding strength. Moreover, it was reported that the remaining adhesive on the debonded enamel surface provides a chemical and mechanical adhesion area for rebonding.[4] In our study, we treated the enamel surfaces of half of the samples and left the other half untreated. In the present study, the untreated brackets showed lower SBS results than the conventionally treated group, and this finding is consistent with the results from previous studies.[1,16]

Zhang *et al.*[11] suggested the exclusion of the pre-etching step of the enamel before rebonding to avoid the enamel fracture risk due to very high rebonding strengths. In our study, in the untreated samples, we did not apply acid etching to the debonded enamel surfaces.

Several methods have been suggested in previous studies for the removal of the residual adhesive from the debonded bracket bases before rebonding, such as sandblasting, mechanical grinding, adhesive burning, and lasers.[6] In our study, we microetched the bracket base by sandblasting after burning the residual adhesive on the surface.In a previous study, it was reported that micro etching by sandblasting provides a better bond strength.[5,15] Yassaei *et al.*[2] reported that burning off the adhesive remnants on the debonded bracket causes the discoloration of the bracket, which has an anesthetic effect on both the patient and the clinician who can inhale the toxic fumes during the burning process. Moreover, Chetan and Muralidhar[18] reported that the burning off method can reduce the hardness of brackets, whereas Buchman[19] reported that this was not of clinical importance. Halwai *et al.*[20] compared the rebonding SBS of brackets treated with air abrasion, flaming, and grinding techniques. They founded that flaming alone did not provide a higher SBS compared with air abrasion. In the same study, air abrasion yielded the highest rebonding SBS. In this study, the SBS values of the sandblasted brackets were higher than that of the untreated group, which was consistent with previous reports.[15,21]

Conclusion

(1) The shear bond test results of rebonded brackets on the treated enamel surface with burs and conventional acid-etch technique showed significantly higher values than with the untreated brackets on untreated enamel surfaces.
(2) Rebonding of the untreated brackets on the untreated enamel surfaces showed clinically nonacceptable SBS values.
(3) The null hypothesis was rejected.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Bishara SE, Laffoon JF, Vonwald L, Warren JJ. The effect of repeated bonding on the shear bond strength of different orthodontic adhesives. Am J Orthod Dentofacial Orthop 2002;121:521-5.
2. Yassaei S, Aghili H, KhanPayeh E. Comparison of shear bond strength of rebonded brackets with four methods of adhesive removal. Lasers Med Sci 2014;29:1563-8.
3. Egan FR, Alexander SA, Cartwright GE. Bond strength of rebonded orthodontic brackets. Am J Orthod Dentofacial Orthop 1996;109:64-70.
4. Montasser MA, Drummond JL, Evans CA. Rebonding of orthodontic brackets: Part I, a laboratory and clinical study. Angle Orthod 2008;78:531-6.
5. Kachoei M, Mohammadi A, Moghaddam ME, Rikhtegaran S, Pourghaznein M, Shirazi S. Comparison of multiple rebond shear strengths of debonded brackets after preparation with sandblasting and CO2 laser. J Dent Res Dent Clin Dent Prospects 2016;10:148-54.
6. Wendl B, Muchitsch P, Pichelmayer M, Droschl H, Kern W. Comparative bond strength of new and reconditioned brackets and assessment of residual adhesive by light and electron microscopy. Eur J Orthod 2011;33:288-92.
7. Eminkahyagil N, Arman A, Çetinşahin A, Karabulut E. Effect of resin-removal methods on enamel and shear bond strength of rebonded brackets. Angle Orthod 2006;76:314-21.
8. Artun J, Bergland S. Clinical trials with crystal growth conditioning as an alternative to acid-etch enamel pretreatment. Am J Orthod Dentofac Orthop 1984;85:333-40.

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9. Sohrabi A, Jafari S, Kimyai S, Rikhtehgaran S. Er,Cr:YSGG laser as a novel method for rebonding failed ceramic brackets. Photomed Laser Surg 2016;34:483-6.
10. Kilponen L, Lassila L, Tolvanen M. Effect of removal of enamel on rebonding strength of resin composite to enamel. Biomed Res Int 2016;2016:1818939.
11. Zhang QF, Yao H, Li ZY. Optimal enamel conditioning strategy for rebonding orthodontic brackets: A laboratory study. Int J Clin Exp Med 2013;7:2705-11.
12. Reynolds IR. A review of direct orthodontic bonding. Br J Orthod 1975;2:171-8.
13. Ahrari F, Poosti M, Akbari M, Sadri K. Early versus delayed rebonding of orthodontic brackets. Prog Orthod 2012;13:17-22.
14. Jassem HA, Retief DH, Jamison HC. Tensile and shear strengths of bonded and rebonded orthodontic attachments. Am J Orthod Dentofac Orthop 1981;79:661-8.
15. Mui B, Rossouw PE, Kulkarni GV. Optimization of a procedure for rebonding dislodged orthodontic brackets. Angle Orthod 1999;69:276-81.
16. Bishara SE, VonWald L, Laffoon JF, Warren JJ. The effect of repeated bonding on the shear bond strength of a composite resin orthodontic adhesive. Angle Orthod 2000;70:435-43.
17. Pakshir HR, Najafi HZ, Hajipour S. Effect of enamel surface treatment on the bond strength of metallic brackets in rebonding process. Eur J Orthod 2012;34:773-7.
18. Chetan GB, Muralidhar RY. Comparative evaluation of four office reconditioning methods for orthodontic stainless steel brackets on shear bond strength—An in vitro study. Ann Essences Dentist 2011;3:6-13.
19. Buchman DJ. Effects of recycling on metallic direct-bond orthodontic brackets. Am J Orthod 1980;77:654-68.
20. Halwai HK, Kamble RH, Hazarey PV, Gautam V. Evaluation and comparision of the shear bond strength of rebonded orthodontic brackets with air abrasion, flaming, and grinding techniques: An in vitro study. Orthodontics (Chic.) 2012;13:e1-9.
21. Arici S, Ozer M, Arici N, Gencer Y. Effects of sandblasting metal bracket base on the bond strength of a resin-modified glass ionomer cement: An in vitro study. J Mater Sci Mater Med 2006;17:253-8.