Original Research

Are Bonding Agents being Effective on the Shear Bond Strength of Orthodontic Brackets Bonded to the Composite?

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Abstract

Introduction: One of the clinical problems in orthodontics is the bonding of brackets to composite restorations. The aim of this study was to evaluate the shear bond strength of brackets bonded to composite restorations using Excite. **Methods:** Forty brackets were bonded to composite surfaces, which were embedded in acrylic resin. One of the following four protocols was employed for surface preparation of the composite: group 1) 37% phosphoric acid for 60 seconds, group 2) roughening with a diamond bur plus 37% phosphoric acid for 60 seconds, group 3) 37% phosphoric acid for 60 seconds and the applying Excite®, group 4) roughening with diamond bur plus 37% phosphoric acid for 60 seconds and applying Excite®. Maxillary central brackets were bonded onto the composite prepared samples with Transbond XT. Shear Bond Strength (SBS) was measured by a universal testing machine. The ANOVA and Tukey test was utilized for data analysis. **Results:** There was a significant difference between the four groups (P<.000). The lowest and highest SBS were attributed to the Group 1 and Group 4 respectively. There was no significant difference between Groups 1 & 3, 2 & 3 and 2 & 4. However, differences between Group 1 in comparison with Groups 2 and 4 and Group 3 with Group 4 were statistically significant. **Conclusion:** According to the results of this study, the usage of Excite® alone before bonding brackets to composite restorations does not cause an increase in bond strength. However, roughening the composite surface before applying Excite is very effective for improving the bond strength of orthodontic brackets to composite restorations.

Keywords: Bond strength, composite restorations, orthodontic brackets.

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Introduction

Today, adults compose a significant number of orthodontic patients. Therefore, bonding orthodontic brackets to composite restorations is becoming an increasingly common procedure in the daily practice of orthodontics (1-6). Many studies have shown when the aged composite restorations have been polished, contaminated or laboratory processed, the bond strength of them to the new composite restorations is significantly reduced (4,6-11). In order to maximize the bond strength between the two composite restorations, a number of techniques have been suggested in literature such as acid etching, micro etching and the use of chemical agents (12-14).

In restorative dentistry, a number of studies have focused on repairing the composite resin. These studies have demonstrated that the use of intermediate bonding agents e.g. adhesive or saline and roughening the surface of the old composites significantly improve the adhesion of the new composite restorations (15-19). Unlike restorative dentistry, in orthodontics, a durable bond is not intended.

Rather, optimal adhesion to the surface of the composite restoration is sought which allow for orthodontic treatment without bond failure (13). It has been suggested that bond strengths of 6–10 MPa are sufficient for orthodontic objectives (20).

Although brackets bonded to the freshly roughened surface of an old composite restoration have had clinical

success, some authors recommend an intermediate primer as well (21).

Excite (Ivoclar.Vivadent, Schaan, Liechtenstein) is a fifth-generation, light-activated dentin bonding agent that sometimes called one bottle system. It is recommended for direct bonding of resin composite, Ceromer™, and compomers to enamel and dentin. This type of adhesive combines the primer and bonding agant into a single solution and is acetone-free. A separate etching step still is required (22).

According to the manufacturer, Excite is distinguished from other "one-component" bonding agents in that it contains extremely small (i.e., 12-nanometer) filler particles. Because they are so small, the manufacturer claims that the filler particles can penetrate into the demineralized dentin and contribute to formation of the hybrid layer. Another reported advantage of their small size is that they do not contribute significantly to the adhesive's film thickness.

Few studies in orthodontic fields have been published in literature on this subject, none of which have investigated the usage of Excite as bonding agent. Consequently, the present study was undertaken with the aim of assessing the bond strength of bonded brackets to composite restorations that were subjected to different surface treatments, including the usage of Excite.

Materials and Methods

Forty cylindrical acrylic blocks, with a diameter of 8mm and a length of 16mm, were employed in this study. After complete polymerization with cold cured acryl (Acropars, Tehran, Iran), a retentive cavity, with the dimensions of 6×6×1.5mm, was prepared in each block by a fissure diamond bur (Schoufa, Japan). The opposite walls of this cavity were convergent to increase mechanical retention. This cavity was then filled with anterior dental composite (3M ESPE, Minnesota, USA) with the shade of A2. By a manual instrument the surface of the dental composite was carefully flattened. Afterward, the layer of composite was cured by a light cure unit (Bluephase-C8, Leichtenstein) for 20 seconds. The specimens were randomly divided into four groups of 10.

In the first group, the surface of the composite was etched with 37% phosphoric acid (Ultra Etch, Ultra-Dent, USA) for 60 seconds. Then, the maxillary central brackets (Dentarum Dental Technology, Ispringen, Germany) were bonded using Transbond XT (3M, ESPE, Minnesota, USA) according to the manufacturer's instructions. After positioning the brackets, the excess composite was removed with a scaler and the composite light cured mesially, distally, occlusally and gingivally for 5 seconds for each side, according to manufacturer guideline.

In the second group, after roughening the surface of the composite with a diamond bur (Schoufa, Japan), phosphoric acid was applied to the surface of the composite and the brackets were bonded in a same manner as group 1.

In the third group, after using phosphoric acid and rinsing, Excite (Ivoclar, Vivadent, Schaan, Leichtenstein) was applied by a microbrush on the surface of the composites. After light curing of the Excite for 20 seconds, the brackets were bonded similar to group 1.

In the fourth group, the specimens were initially roughened with a diamond bur and then the phosphoric acid was applied to the surfaces. After rubbing in the Excite and curing it, the brackets were bonded just like the previous groups.

The specimens were then stored in an incubator (Thelco, GCA, England) for 24 hours at 37˚C and 100% humidity. Shear bond testing was performed using a universal testing machine (Zwick, Germany) at a crosshead speed of 0.5 mm/minute and a 200 kg load cell 23. The shear force was applied vertically across the bracket and the composite interface. The force required to shear the brackets was recorded in Newton measurements. The bond strengths were calculated in megapascals (MPa) by dividing the force to the surface of the base of the brackets (2mm).The results were statistically analyzed using one-way ANOVA and Tukey. The level of significance for all tests was determined at $P<0.05$.

Results

The normal distribution of data was confirmed by the Kolmogorov-Smirnov test. The descriptive data of the shear bond strength of the different groups is shown in Table 1.The highest bond strength was that of Group 4, which used roughening and bonding in addition to acid. Group 1 had the lowest bond strength which used only acid etch technique before bonding the bracket. In addition Table 1 presents the ANOVA results. According to this analysis, there was a significant difference in the shear bond strength of the different groups ($P<0.001$).

The results of the Tukey test are given in Table 2. This test indicated that there were significant differences between the shear bond strength of groups 1 and 2 ($P=0.007$), groups 1 and 4 ($P=0.001$) and that of group 3 when compared with Group 4 ($P=0.015$). However, the differences of shear bond strength of Groups 1 and 3, Groups 2 and 3 and Groups 2 and 4 was not statistically significant.

Table 1. Descriptive statistics of shear bond strength of different groups and ANOVA result

Group	N	Mean	Sd. Deviation	Sd. Error	P-Value
1	10	5.8315	3.11189	.98407	<0.001
2	10	11.3697	3.81686	1.20700	
3	10	8.9593	3.38463	1.07031	
4	10	13.7543	3.17005	1.00246	
Total	40	9.9787	4.40309	.69619	

(group 1: acid, group 2: acid+roughing, group 3: acid+bonding, group 4: acid+roughing+bonding)

*The mean difference is significant at the .05 level

Table 2. Tukey test results of shear bond strength differences of four study groups

Group	N	Subset for alpha = .05		
		1	2	3
1	10	5.8315		
3	10	8.9593	8.9593	
2	10		11.3697	11.3697
4	10			13.7543
Sig.		.183	.395	.404

(group 1: acid, group 2: acid+roughing, group 3: acid+bonding, group 4: acid+roughing+bonding)

Discussion

Clinical studies that assess the shear bond strength of orthodontic brackets are extremely difficult to conduct. It is virtually impossible to standardize the oral status of each patient, which hinders the prediction of durability and the comparison of dental materials 24. Thus, laboratory methods have been proposed to simulate oral conditions and facilitate comparisons among different dental materials.

In order to improve the bond strength of new composite restorations to previous composite fillings, various techniques have been presented such as acid etching, micro etching and the use of chemical agents in restorative dentistry (12-14).

This study used four protocols for preparing the composite surface before the bonding of brackets, including the application of phosphoric acid, the creation of roughness, the rubbing of Excite, and a combination of these methods.

As recommended by numerous researchers, roughening the bonded surface results in increased bond strength (25). Similarly, the results of the present study also suggest that roughening the surface of composite restorations enhances bond strength. The findings of Chay et al. (26) support the claim that treatment, such as roughening with greenstone or sandblasting the surface of the provisional material, produced increased bond strength of orthodontic brackets after artificial aging.

A previous study (23) found that, when stainless steel brackets are bonded to composite restorations, treated with diamond bur there is significant higher shear bond strength than those, bonded to composite surfaces treated with hydrofluoric acid. Those results are similar to the current study, except that phosphoric acid was used in the latter instead of hydrofluoric acid.

Germec et al concluded that air abrasion leads to more improved retentive surfaces than roughening with a diamond bur when bonding brackets to amalgam (25). Although no previous study has investigated the effect of a bonding agent, such as Excite on the shear bond strength of orthodontic brackets bonded to a composite, the most similar study to date was performed by Eslamian (27). Eslamian et al reported that using a silane agent offered no advantage when bonding orthodontic brackets to composite restorations (27). Their study supports the current study's findings that the usage of an intermediate agent alone, such as Excite, has no effect on shear bond strength.

In the present study, however, the strongest bond strength was achieved with the application of Excite in addition to roughening and acid etching on the composite surface. The role of Excite in bond strengthening is attributed to its capability of improving surface wetting. Excite, as a bonding agent, by enhancing the wetting of composite restoration surfaces can lead to the formation of more resin tags. Increasing

the number of resin tags boosts the shear bond strength of brackets to composite restorations. It seems that roughening the composite surface provides conditions for Excite to form more resin tags and so augment bond strength.

Conclusion

According to the results of this study, the usage of Excite® alone before the bonding of brackets to composite restorations does not cause an increase in bond strength. However, roughening the composite surface is very effective in improving of the bond strength of orthodontic brackets bonded to composite restorations, especially before the application of Excite.

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