Shear Bond Strength of Repaired Composite Using Single Bond Adhesive

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Abstract

Objectives

The aim of this study is to evaluate the shear bond strength of repaired composite resin restorations using one step Single Bond Universal adhesive.

Materials and Methods: 60 cylindrical composite samples (8×9mm) were prepared from Filtek Z350 XT, light cured and stored for 6 weeks. The surface of each sample was bur roughened and acid etched with 32% phosphoric acid. Samples were randomly assigned into 2 groups (n=30). For group 1 (control), the silane coupling agent and the bonding agent were applied in two separate steps. For group 2 (test), a Single Bond Universal adhesive contains the silane and bonding agent was applied on the surface of the samples. Fresh composite resin was bonded to treated surfaces, cured and stored for another 6 weeks. The shear bond strength (SBS) was measured and analyzed statistically using independent sample t-test.

Results: The mean initial failure SBS for the test group was significantly higher than that of the control group (P<0.001).

Conclusion: Single Bond Universal adhesive provides more reliable bond strength for repaired composite resin restorations compared with two steps saline and bonding agent application.

Keywords: Composite; Repair; Silane; Shear; Single bond universal adhesive

Introduction

Composite resin restorations are the most widely used dental filling material for restoration of teeth in dental practice nowadays. However, these restorations are subjected to different degenerative changes during their service intra-orally as they undergo deterioration and wear [1]. Approximately 50% of resin-based composite restorations are replaced after five years of service, and the main reasons are secondary caries, marginal staining, marginal defects, marginal or body fracture, discoloration, degradation and loss of anatomic form, unsatisfactory shade, and painful symptoms [2-5].

Traditionally, replacement was the ideal approach to treat defective composite restorations; however, repairing composites offers an alternative and more conservative approach where restorations are partly still serviceable [6]. Repairing composite restoration may be considered the treatment of choice for surface discoloration of existing restorations, small areas of recurrent caries along the margin of an otherwise sound composite restoration, or when complete removal of a very large composite restoration would unnecessarily jeopardize the health of a tooth, as well as laboratory fabricated (indirect) resin composite repair [7]. A recent clinical study involved composite resin repairs have shown that, when properly planned, the repairs may increase the clinical longevity of restorations [8]. The efficiency of the repair is related to the magnitude of the bond strength obtained at that interface [9]. The bond strength between increments of composite should be equal to the cohesive strength of the material. If the composite has been contaminated, polished, processed in a laboratory (indirect composite restorations), or aged, the adhesion to a new composite is reduced up to 25% of the original cohesive strength [10-12].

When placing a composite restoration using layering technique, the un-reacted molecules, present in the air inhibited
A cylindrical mold made of vinyl polysiloxane duplicating material (elite double, Zhermack, Ohlmuhle, Germany) was used to prepare 60 samples (8mm height and 9mm diameter) of Filtek Z350 XT composite (3M ESPE, St Paul, MN, USA). Two increments (2mm) of A2 dentin shade were packed inside the mold to yield a 4mm height sample. Each increment was initially light polymerized (starlight pro, mectron, Carasco, Italy) for 40s. The sample was removed from the mold and an additional 40s light curing was achieved on each side of the sample. The light output was calibrated according to the manufacturer’s instructions. All samples were stored in a dry environment for 24 hours.

After 24 hours, samples were finished under water with high speed fine diamond finishing bur (Dia-Tessin, Vanetti SA, Gordevio, Switzerland), and polished with low speed green and pink soflex (3M ESPE, St Paul, MN, USA) finishing discs. Each sample was rinsed for 15s with water and stored in distilled water for six weeks at 37°C.

The samples were randomly assigned to a control group and a test group (n=30). In group 1 (control), the composite surfaces were roughened using high speed rough diamond bur (Dia-Tessin) under water (5 strokes over 5 seconds). Then 32% Phosphoric acid gel (Scotchbond universal etchant, 3M ESPE, St Paul, MN, USA) was brushed on the composite surface for 30s using micro brush. The acid was rinsed for 15s and dried for 15s. Silane coupling agent (RelyX, 3M ESPE, St Paul, MN, USA) was applied to the etched composite surface and allowed to dry for 60s. Finally, two coats of the bonding agent (Adper single bond 2, 3M ESPE, St Paul, MN, USA) was applied on the composite surface with 5s waiting time and then light cured for 20s.

In group 2 (test): the composite surfaces were roughened and etched in the same manner as in the control group. Single Bond Universal (SBU) adhesive (3M ESPE, St Paul, MN, USA) was applied on the composite surface with a disposable applicator and rubbed in for 20s. Subsequently, a gentle stream of air was directed over the liquid for 5s, and then light cured for 10s.

All treated samples were re-inserted in their molds, and a fresh Filtek Z350 XT composite layer of 2mm thickness was condensed over each prepared surface and light cured for 40s. A different shade (A2 enamel shade) was chosen for the repairing composite in order to enable visual identification and orientation of the repair interface during shear bond strength (SBS) testing. Another 2mm layer of composite was applied and cured for another 40s. Each sample was then light cured from all sides for additional 40s after removing it from the mold. All samples were kept dry for two weeks before testing the shear bond strength.
The samples were mounted in the jig of a Universal shear-testing machine with a semicircular loading surface (JINAN material testing machine, Jinan, China) as shown in (Figure 1). The shear bond strength was determined at a crosshead speed of 0.5m/min. The shear bond strength (SBS) was calculated by dividing the failure force by the cross sectional area of the samples according to the following equation:

\[ \text{SBS (MPa)} = \frac{\text{Load (N)}}{\text{area (mm}^2\text{)}}. \]

**Statistical analysis**

Statistical analysis was performed using SPSS for Windows release 16.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were generated. Independent sample t-test was used to examine differences between groups. Results were considered significant if P-values were less than 0.05.

**Results**

![Figure 2: Shear bond strength values at initial failure for both control and test groups (MPa).](image)

The mean shear bond strength (SBS) for the test group (16.27±5.37) was significantly higher than that of control group (11.78±2.63), (P<0.001). The SBS results for both control and test groups are presented in (Figure 2).

**Discussion**

In the current study we evaluated the strength of SBU adhesive, which was purchased from 3M ESPE, USA. The SBS of repaired composite resin restorations with the application of SBU adhesive should be at least as strong as the SBS of composite resin restorations repaired with silane coupling agent and bonding adhesive applied separately.

The results of the present study demonstrated that the mean initial failure (loss of bonding) SBS for the test group was significantly higher than that of the control group.

When repairing old composite restorations, surface pretreatment of the old composite has two purposes; to remove the superficial layer altered by the saliva exposing a clean higher energy composite surface, and to increase the surface area through creation of surface irregularities [26]. Bonding between old and new composite may occur by three distinct mechanisms:

a. Through a chemical bonding with the organic matrix;

b. Through a chemical bonding with the exposed filler particles, and

c. Through micromechanical retention to the treated surface [14].

In the present study we used bur roughening with rough diamond burs to provide micromechanical retention [16,27]. Etching procedure was used to facilitate bonding because it creates a porous surface in which this porosity lead to increase the retentive bond [28,29]. SBU adhesive application showed comparable but lower SBS values to the values demonstrated by 3MESPE regarding bonding to enamel (25 MPa) and dentin (30 MPa), which was the only source of data for comparison [30].

Bonding composite to enamel and dentin was thoroughly investigated in literature, and SBS to both substrates was reported to be about 15-30 MPa and 17-24 MPa for enamel and dentin, respectively [7,22]. On the other hand, SBS values for composite resin restorations repair varies greatly according to several factors such as; composition of the composite material, surface pretreatment protocol, aging method etc. However, it is clearly stated in the literature that intermediate bonding agents and silanization could enhance bonding during repairing composite resin restorations [21-25,31,32]. Our results confirm the previous stated data about the importance of bonding and silanization steps in composite repairs [14,33,34]. The bi-functional molecule of the silane coupling agent bonds the inorganic filler particles of the resin with the methacrylate of the adhesive system, and increases the wet ability of the adhesive system to infiltrate into the irregularities of the treated composite surface [34].

![Figure 3: Representative sample from control group with adhesive failure in the composite substrate (x8).](image)

![Figure 4: Representative sample from test group with cohesive failure in the composite substrate (x8).](image)

The mode of failure which was evident macroscopically due to different shades (A2 enamel versus A2 dentin) of composite materials which were used for the original samples and the...
repairing layers necessitated the stereomicroscope examination to assess the mode of failure more precisely. 80% of the control group samples failed adhesively, while all the test group samples showed cohesive and mixed mode of failure observed under the stereomicroscope as shown in (Figure 3 & 4).

Conclusion

Within the confines of this study we concluded that the application of the SBU adhesive during repairing composite resin restorations is efficient and convenient.

References