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ORIGINAL RESEARCH

The Impact of Expasyl® Gingival Retraction Paste on the Bond Strength of Self-etch and Total-etch Systems

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ABSTRACT

Objective: To evaluate the influence of Expasyl® gingival retraction paste on the shear bond strength of self-etch and total-etch adhesive systems.

Materials and methods: Twenty-four specimens of extracted, caries-free, sound human molars were used in this study. The molars were then cut vertically into halves through the buccal and lingual cusps. Forty-eight specimens were divided into four groups (total-etch, total-etch with Expasyl application, self-etch, self-etch with Expasyl application) and the shear bond strength was tested.

Results: Expasyl significantly reduced the shear bond strength of the self-etch and total-etch adhesive systems. The self-etch system showed relatively lower performance compared with the total-etch adhesive system. The shear bond strength values of the total-etch adhesive without Expasyl showed the highest bond strength (21.48 ± 2.89), while the self-etching group adhesive treated with Expasyl showed the lowest shear bond strength value (14.89 ± 1.81).

Conclusion: From the observations of this *in vitro* study, it can be concluded that the use of Expasyl® gingival retraction system can negatively affect bond strength of adhesives. The total-etch system showed better compatibility to the Expasyl gingival retraction system than the self-etch.

Keywords: Self-etch, Total-etch, Bond strength, Gingival retraction, Expasyl®.

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INTRODUCTION

Eliminating contamination with blood, saliva and gingival crevicular fluid during restoration is critical for the longevity of the restorations which are located close to the gingival margin.[1] While the use of a rubber dam is mandatory for all adhesive restorations, this is not being consistently practiced by the clinicians and alternative moisture control techniques are routinely used.[2] Moisture and blood contamination might adversely affect the bond strength between adhesives and tooth structures. The success of a restoration relies on a durable and predictable bond between adhesive dental materials and underlying tooth structures in modern dentistry.[3]

New adhesive systems have been developed in an attempt to reduce the steps and to simplify clinical bonding procedures in restorative dentistry.[4] A durable bonding and successful adhesion can be achieved by eliminating any kind of moisture contamination of the prepared cavity walls before application of resin composite and adhesive systems. Two major simplified bonding approaches are currently available; the total-etching and self-etching systems. Total-etching utilizes the technique to simultaneously remove the smear layers from both enamel and dentin surfaces, followed by the application of a one-bottle agent that combines the primer and the adhesive in one solution.[5] Since the system utilizes the demineralized collagen fibril mesh as the bonding substrate, a wet bonding technique is required to insure its full expansion.[6] The mechanism behind the self-etching system is based upon the simultaneous

etching and priming of the smear-covered dentin using an acidic primer, followed by the application of an adhesive resin.[7,8] The self-etching primers eliminate the separate acid etching and rinsing steps, simplifying bonding technique and reducing its technique sensitivity.[9]

The gingival retraction can be achieved by mechanical, chemical, surgical or a combination of these methods. Application of retraction cords alone or impregnated with chemicals is a well-established technique in practice due to their relative predictability, effectiveness and safety.[10] However, the use of retraction cord can be laborious, time-consuming, can cause gingival bleeding, uncomfortable for patients in the absence of anesthesia, and when inappropriately manipulated, can lead to direct injury and gingival recession.[11-13] Several hemostatic agents with varying degrees of safety and effectiveness are available, such as aluminum potassium sulphate (Alum), aluminum chloride, epinephrine, zinc chloride, ferric sulphate and sympathomimetic amines.

Recently, cordless techniques have been introduced with several advantages, such as time-saving and enhanced patient comfort while being minimally invasive (Bennani et al, 2008). Expasyl® (Kerr Corp., Orange, CA, USA) utilizes a mechanical and chemical component for sulcus opening and hemostasis. It is comprised of three materials: kaolin, water and aluminum chloride. Expasyl contains white clay (kaolin) to ensure the consistency of the paste and its mechanical action, while aluminum chloride enhances the hemostatic action.[14] The effectiveness of retraction procedures has been evaluated under clinical conditions and in the laboratory.[10,15] Reports on self-etching adhesives have demonstrated variations in bond strength values,[16-18] and contradictory results have been reported regarding bonding performances after tooth treatment.[2,19,20] Hence, the objective of this *in vitro* study was to assess impact of Expasyl® on the shear bond strength of two adhesive systems: total-etch and self-etch bonding material.

MATERIALS AND METHODS

The study was approved by the Institutional Review Board of the College of Dentistry Research Centre (CDRC), College of Dentistry, King Saud University. A total of 24 extracted molars were used in this study. They were examined with a magnifying glass and the specimens with caries, cracks or fractures were discarded.

Tooth preparation: The buccal and lingual sides of the molars were gently grounded to expose the dentin using Jean Wirtz Automatic Grinding and Polishing Machine (Jean Wirtz, Germany). The molars were then cut vertically into halves through the buccal and lingual cusps. Sectioning was performed using a circular diamond saw fitted on a clinical bur along with a constant spray of water. The cut sections were then embedded in PVC cylinders using cold-cure acrylic resin, exposing the dentin surfaces. This was then subjected to grinding to obtain an even dentin surface in order to avoid contamination from the acrylic resin. The 48 specimens were divided into four groups (12 each) and the shear bond strength is tested in the four groups.

Group A-total-etch + Expasyl: Expasyl was applied to the dentin using a cannula and removed with water spray after 2 minutes as per the manufacturer instructions. Dentin was then etched with Ultra etch, a total etchant (35% Phosphoric acid, Ultradent Products Inc., Germany) and washed out after 30 seconds. The adhesive Prime and Bond NT (Dentsply Caulk, Milford, Delware) was applied with a microbrush and light cured using 3 M ESPE Elipar 2500 for 10 seconds. The composite (Tetric Ceram, Ivoclar Vivadent, Germany) was packed incrementally on the dentin surface in a cylindrical mold 4.5 mm in diameter and 3 mm in height and each increment was then light cured for 40 seconds.

Group B-total-etch: The same procedure was done as in Group A without the application of Expasyl.

Group C-self-etch+ Expasyl: Expasyl was applied on the dentin using a cannula and removed after 2 minutes with water spray. It was then etched with Compobond DC (Promedica, Germany) a dual curing self-etch adhesive and light cured for 10 seconds. The composite (Tetric Ceram, Ivoclar Vivadent, Germany) was then packed incrementally on the dentin surface in a cylindrical mold 4.5 mm in diameter and 3 mm in height, and each increment was then light cured for 40 seconds.

Group D-self-etch: The same procedure as in Group C was carried out, without the application of Expasyl.

Shear Bond Strength Testing

The shear bond test was performed for each specimen using the universal testing machine (Instron 8500, USA) (Fig. 1). The dentin cylinder was fixed horizontally on the lower mobile platform against the chisel head, which was directed at the composite-dentin interface. The shear force was applied to each specimen at a cross head speed 0.5 mm/minute and the load cell was 20 kN. Shear bond strength (SBS) in Megapascal (MPa) was calculated from the peak load at failure divided by the specimen surface area.

Statistical Analysis

Statistical analysis of the data was performed using the GraphPad InStat® software (InStat, GraphPad IntStat,

Fig. 1: Shear bond strength test specimens in the universal testing machine

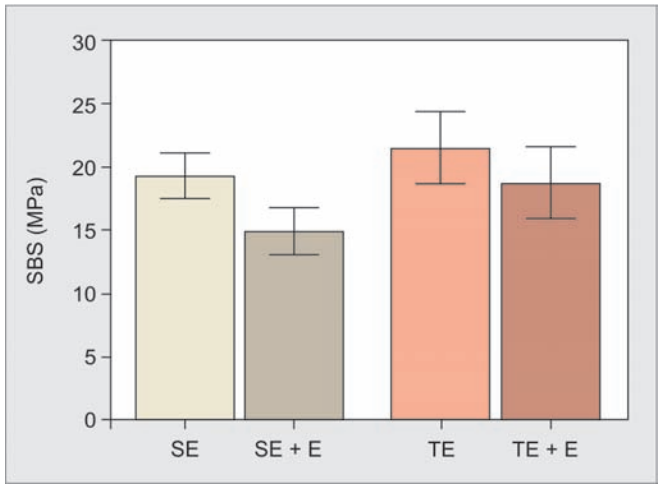

Fig. 2: Mean shear bond strengths of total-etch and self-etch adhesives to dentin surfaces, with or without Expasyl (SBS: Shear bond strength; SE: self-etch; SE + E: self-etch with Expasyl; TE: total-etch; TE + E: total-etch with Expasyl

Inc., San Diego, CA, USA). Differences between the four study groups were determined with one-way analysis of variance (ANOVA). When an overall ANOVA showed statistical significance, post hoc testing (Tukey-Kramer multiple comparisons test) was performed to explore the differences between any two groups. p-values < 0.05 were considered significant.

RESULTS

The mean values and standard deviation of the shear bond strengths of each group are shown in Table 1. There was a significant difference in the bond strength between samples treated with Expasyl to those without Expasyl in both groups. The mean bond strength of self-etch system was 19.27 ± 1.80 which got significantly reduced when the retraction system was used (14.89 ± 1.81). Similarly, the total-etch also showed a significant reduction in bond strength (21.48 ± 2.89 to 18.73 ± 2.86) when the Expasyl retraction paste was applied to the tooth surface (Fig. 2). Even though total-etch showed higher bond strength compared with self-etch without the application of Expasyl it was not significant. However, when the retraction system is applied the total-etch showed significantly higher bond strength compared with self-etch ($p < 0.01$). The shear bond strength values of the total-etch adhesive without Expasyl showed the highest bond strength (21.48 ± 2.89), while the self-etching group adhesive treated with Expasyl showed the lowest shear bond strength value (14.89 ± 1.81).

Table 1: The mean values and standard deviation of the shear bond strengths of self-etch and total-etch with and without Expasyl gingival retraction paste application

	Shear bond strength (MPa)		
Groups (n = 12)	*Mean ± SD*	*Minimum*	*Maximum*
Self-etch + Expasyl	14.89 ± 1.81	12.42	17.97
Self-etch	19.27 ± 1.80	15.89	22.26
Total-etch + Expasyl	18.73 ± 2.86	12.05	22.32
Total-etch	21.48 ± 2.89	16.83	26.01

SD: Standard deviation

DISCUSSION

Retraction of gingiva is widely used in dentistry for direct and indirect restorative procedures. Chemomechanical methods are currently the most popular in dental practice to combine retraction materials with chemical agents. The bonding agents are sensitive to moisture and blood contamination. The bleeding or sulcular fluid released following the gingival trauma can affect the bond strength of the restorative materials used. A dry operative field can be obtained by applying hemostatic agents. Aluminum chloride, aluminum sulfate and ferric sulfate are the common hemostatic components; however, these are highly acidic and their pH values vary from 0.7 to 3.02.

Expasyl (Kerr Corp., Orange, CA, USA) is apaste-like gingival retraction material that depends on the hemostatic properties of aluminum chloride and the hygroscopic expansion of kaolin upon contact with the crevicular fluid, to provide retraction of the gingiva.[14] The dentin surfaces treated with hemostatic agents show various degrees of demineralization. Complete smear layer removal can be observed following application of hemostatic agents after 5 minutes,[21] and it has been reported that the smear layer may affect the adhesion of self-etching adhesives.[22] Reports on self-etching adhesives have demonstrated variations in bond strength values[16-18] and contradictory results have been reported regarding bonding performances[2,19,20]

In the present study, the bond strength of two different bonding agents was tested with and without application

of Expasyl gingival retraction system. The results showed that significant reduction in the bond strength was observed with both systems after the application of the retraction paste. Hence, it can be concluded that use of this hemostatic agent interfere with the bond strength of the commonly used restorative materials. This observation was in agreement with earlier studies using other gingival retraction systems.[2,19,23]

Expasyl® is a widely used gingival retraction paste composed of three materials: Aluminum chloride (≈ 15%), kaolin, and excipient. It is available in reusable capsules that will be decontaminated after each use and the disposable injection cannula allows for bending and shaping.[24,25] The consistency of Expasyl® is formulated to prevent damage of the healthy periodontium and to avoid gingival recession, or bone resorption.[19] A single application of Expasyl in the sulcus results in gingival retraction. Due to its color, Expasyl is very visible and may be eliminated by air and water spray, such that a dry and widely opened sulcus is available after 1 to 2 minutes. It is painless, when used on a healthy periodontium and offers a perfectly dry sulcus, without bleeding or oozing.[26]

Self-etching adhesives do not require rinsing, conditioning or primers to function.[25] They have higher pH values than the acids used with total-etch adhesive systems, and they are not rinsed away. The smear layer or its components are incorporated into the bonded layers.[20] The effects of self-etching adhesives in combination with gingival retraction materials on tooth structures are variable. Some reports have shown that self-etching adhesives perform well on enamel and dentin in the presence of astringents, whereas others reported insufficient bonding results.[2,24,26] In the present study, the bond strength of self-etching adhesives to Expasyl® contaminated dentin was low compared to other test groups. The dentin bonding mechanism of self-etching adhesive occurred via the incorporation of the self-etching adhesive resin into the exposed collagen network and modified smear layer.[4,27] The adhesive Compobond DC used in this study had a weak acidity with a pH of approximately 2. Therefore, the demineralization effect on dentin may have been decreased. The Compobond DC bonding protocol does not include phosphoric acid etching. This adhesive appears to be more susceptible to reduction in bond strength due to the lack of the need for preconditioning of the dentin with phosphoric acid. As such, it was critical to rinse and cleanse the dentin with self-etching adhesive systems after Expasyl application. This might explain the bond strength reduction of Compobond DC to Expasyl contaminated dentin.

In addition, we showed that the effect of self-etching adhesives on dentin etching was reduced after the application of Expasyl on the dentin surface. This was in agreement with a previous report, which showed that self-etching adhesives are more susceptible to a reduction in bond strength due to the lack of the need for phosphoric acid etching of dentin.[16,28]

The bond strength of the total-etch system, in this study was significantly higher than the self-etching system, even after contamination with Expasyl. The contamination of the dentin surface with Expasyl did not have a detrimental effect on bond strength. In the total-etching technique, dentin surfaces were etched with phosphoric acid etchant of pH 0.5, which resulted in contaminant removal and simultaneous demineralization of dentin surfaces.[3]

CONCLUSION

Within the limitations of this *in vitro* study, it can be concluded that the use of Expasyl® gingival retraction system can negatively affect bond strength of adhesives. The self-etch system showed relatively lower performance compared with the total-etch adhesive system. Further, studies on the effect of rinsing the dentin surface with water, a dentin cleansing product or etching with phosphoric acid prior to bonding may be useful to overcome the deleterious effect of the reaction systems used in adhesive dentistry.

CONFLICT OF INTEREST

The authors have no known conflicts of interest associated with the products used in this study and there has been no significant financial support for this work that could have influenced its outcome.

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