Effect of Blood Contamination and Decontamination Procedures on the Microtensile Bond Strength of a New Self-etch Adhesive: An in vitro Study

Asiya Shaikh, Vivek Hegde, Srilatha Shanmugasundaram

ABSTRACT

Aim: The aim of the study was to evaluate the effect of blood contamination and decontamination procedures on the microtensile bond strength of a new self-etch adhesive before and after curing.

Materials and methods: A total of 90 human extracted mandibular molars were stored in 0.5% thymol solution and distilled water. Midcoronal sections were obtained using a diamond disk and the dentin surface was ground with 320 grit Sic abrasive paper. Universal self-etch adhesive (3M ESPE) and Filtex Z-250 resin composite were used. The dentin specimens were randomly divided into nine groups: Control group, group I—blood contamination before curing, group II—blood contamination before curing followed by air drying, group III—blood contamination before curing followed by rinsing with water and air drying, group IV—blood contamination before curing followed by rinsing with water, air dry, and reapplication of bonding agent, group V—blood contamination after curing, group VI—blood contamination after curing followed by air dry, group VII—blood contamination after curing followed by rinsing with water and air drying, group VIII—blood contamination after curing followed by rinsing with water, air dry, and reapplication of bonding agent. The microtensile bond strength was measured by universal testing machine and the data were analyzed by one-way analysis of variance (ANOVA) followed by Tukey’s post hoc test.

Results: The contamination groups (I, V) showed the least bond strength followed by the decontamination groups (II, III, VI, VII). The reapplication groups (IV, VIII) restored the bond strength equal to control group.

Clinical significance: A contamination-free area is required for adequate adhesion. It is important to rule out measures to prevent and manage contamination, so as to achieve durable seal between composite resin and tooth surface.

Keywords: Blood contamination, Filtex Z-250, Microtensile bond strength, Single-bond universal adhesive.

INTRODUCTION

The increasing demand for esthetic restoration has led to a drastic increase in clinical applications of and intensive research on adhesives. The fundamental requirement of resin composite is durable adhesion of the composite to tooth structure. In order to generate a durable seal between the restoration and tooth surface, successful adhesion without contamination is necessary. Contamination with saliva and blood commonly occurs during the procedure; rubber dam isolation is the ideal way to achieve a dry field; however, in clinical routine, it is not always feasible.

There are several studies that indicate that blood contamination significantly reduces the bond strength. According to Kaneshima et al., the effect greatly varies on the surface condition of adherent.

Self-etch adhesives have gained popularity among the clinicians since they are less technique-sensitive, provide ease of application, and reduce clinical steps. Although the short application reduces the risk of contamination, however, it may be sometimes impossible to maintain a contamination-free area, especially when restoring class II and class V. There are limited studies investigating the effect of blood contamination on the microtensile bond strength of self-etch adhesives.

The purpose of the study was to evaluate the effect of blood contamination and various decontamination procedures on the microtensile bond strength of self-etch adhesives at different stages before and after curing.

MATERIALS AND METHODS

Ninety extracted noncarious mandibular molars stored in 0.5% thymol solution and distilled water were used. The teeth were horizontally sectioned to obtained flat
of contamination, which was considered after curing in these groups.

A nanohybrid composite resin (Filtex Z-250, color A3—3M ESPE, USA) was placed in increments into Teflon cylinders (3 × 8 mm). Each increment was light cured for 40 seconds. All the specimens were stored in distilled water for 24 hours followed by thermocycling (5–55°C 15 seconds dwell time). After storage, the specimens were debonded under tension using a universal testing machine (Model No. STS 435) at a cross-head speed of 3 mm/minute. The bond strengths were expressed in MPa.

RESULTS

The microtensile bond strengths for the different groups are summarized in Table 1. The data were analyzed by one-way ANOVA followed by Tukey’s post hoc test. All the contamination groups showed lower bond strength. Groups I (1.02) and V (1.08) showed the least bond strength of p > 0.05 when analyzed statistically. Groups IV (20.0) and VIII (21.09), which were the reapplication groups, restored the bond strength equal to control group (23.2) of p > 0.05. Decontamination groups II (9.08) and VI (10.0) showed significantly lower bond strength with no statistical difference (p > 0.05), group III (0) showed no bond strength, whereas group VII showed bond strength (12.8) with statistically significant difference (Table 2 and Graph 1).

DISCUSSION

Contamination of the operating field is a problem, which occurs while restoring deep proximal and cervical

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**Flow Chart 1:** Schematic presentation of groups in the study

- Blood contamination before curing → Control
  - Air dry → Water spray → Water spray air dry
  - Reapplication of bonding agent
- Blood contamination after curing
  - Air dry → Water spray → Water spray air dry
  - Reapplication of bonding agent

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**Control Group**

Self-etch adhesive (single-bond universal 3M) was applied on the dentin surface according to manufacturer’s instruction using a microbrush and light cured for 10 seconds.

- **Group I:** Self-etch adhesive was applied on the dentin surface, which was followed by contamination using a drop of blood applied directly on the surface, left undisturbed for 15 seconds, and light cured for 10 seconds.

- **Group II:** The same procedure was followed as mentioned above. Additionally after contamination, the decontamination procedure, i.e., air dry was performed 10 cm away from the target tissue for 10 seconds followed by light curing for 10 seconds.

- **Group III:** After contamination of the samples, the decontamination procedure was carried out using water spray 10 cm away from target tissue followed by air dry for 10 seconds and light cured for 10 seconds.

- **Group IV:** After contamination, the decontamination procedure using water spray followed by air dry was carried out, and the adhesive was reapplied and light cured for 10 seconds.

- **Groups V, VI, VII, and VIII:** The same procedure performed in group I, II, III, and IV were repeated in group V, VI, VII, and VIII respectively, except for the stage of contamination, which was considered after curing in these groups.

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**Table 1:** Adhesive used in the study

<table>
<thead>
<tr>
<th>Adhesive</th>
<th>Manufacturer</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-bond</td>
<td>3M ESPE</td>
<td>10-Methacryloyloxydecyl dihydrogen phosphate monomer, dimethacrylate resin, 2-hydroxyethyl methacrylate, vitrebond copolymer, filler, ethanol, water, initiators, silane</td>
</tr>
<tr>
<td>universal</td>
<td>St. Paul, MN, USA</td>
<td></td>
</tr>
</tbody>
</table>

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**Table 2:** One-way ANOVA followed by Tukey’s post hoc test

<table>
<thead>
<tr>
<th>Groups</th>
<th>Number of samples</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>10</td>
<td>23.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.2</td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>10</td>
<td>10.02&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>Group II</td>
<td>10</td>
<td>9.08&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>6.8</td>
<td></td>
</tr>
<tr>
<td>Group III</td>
<td>10</td>
<td>0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>&lt;0.001&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>Group IV</td>
<td>10</td>
<td>20.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>Group V</td>
<td>10</td>
<td>10.08&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>Group VI</td>
<td>10</td>
<td>10.0&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>Group VII</td>
<td>10</td>
<td>12.8&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>Group VIII</td>
<td>10</td>
<td>21.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.1</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>p < 0.001, highly significant; same letters indicate no significant differences between groups (p > 0.05); **Indicate highly significant statistically
lesions. Rubber dam isolation is mandatory to achieve a dry field; however, in many clinical situations, the placement is difficult and contamination may occur. In this study, the effect of blood contamination on microtensile bond of self-etch adhesive was evaluated. Contamination of blood was carried out before and after curing along with different decontamination procedures that are commonly used clinically.

The adhesive strategy of self-etch adhesive relies on smear layer dissolution. Hence, for laboratory testing of self-etch adhesives, it is recommended to form a smear layer that closely resembles that of which is formed clinically. Oliveira et al. demonstrated that 320 grit silicon carbide paper creates a clinically relevant smear layer. The carbide and diamond burs and disk, which are most frequently used to obtain a dentin specimen, create a smear layer, i.e., not clinically relevant. Hence, in this study, the enamel was removed with a diamond disc followed by wet sanding on the dentin surface with 320 grit silicon carbide paper in order to obtain a standardized smear layer.

There are various studies showing that blood contamination affects the bond strength. However, the literature contains many discrepancies, particularly, in the terms of type of blood used and the storage period. There are two opinions with regards to type of blood to be used; one recommends fresh blood, while the others recommend blood with anticoagulant. The influence of blood contamination on bond strength is attributed to its high protein content that, along with macromolecules, such as fibrinogen and platelets that form a film on the dentin surface, obstructs the penetration of the adhesive system into dentinal tubules. Adding an anticoagulant to blood will not allow the formation of a blood film, ultimately giving confounding results. Hence, fresh blood that was immediately drawn was used in this study in order to simulate the clinical condition.

Self-etch adhesives have gained popularity due to reduced clinical steps that probably will reduce the risk of contamination. In this study, single-bond universal adhesive (3M) was used, which is a seventh-generation bonding agent, which is both hydrophilic and hydrophobic in nature thus, providing good strength at both wet- and dry-etched dentin. It provides a distinct hybrid layer and resin tags, which improve bond strength. Hence, single-bond universal adhesive was selected in this study to evaluate whether contamination with blood affects the bond strength.

The bond strength achieved in the control group was 23.2 MPa. Groups I and V, which were the contamination groups, showed significantly lower bond strength, which cannot be clinically acceptable. The various decontamination procedures that are commonly used by clinicians, i.e., air dry, water spray, and reapplication of adhesive are considered in this study. The decontamination group II showed lower bond strength than group VI, but was not statistically significant (p > 0.05). It is because decontamination using air dry is not sufficient enough to remove the contaminant from the dentin surface. The decontamination group III showed immediate debonding, and, hence, the bond strength recorded was 0. Group VII showed bond strength of 12.8 ± 8.4, which is relatively less as compared with the control group. Hence, it is clear that the decontamination procedure, i.e., air dry followed by water spray is not sufficient to achieve adequate bond strength. The reason behind the poor bond strengths with groups II, III, V, and VI might be the fact that the remnants of blood protein or excess water, which was not removed, could have impaired the adhesion. The decontamination groups IV and VIII showed bond strength equal to control, and, hence, it is advisable that whenever the tooth is contaminated, it is necessary to clean the tooth of the contaminant and reapply the adhesive. The findings in this study demonstrate that single-bond universal adhesive, when tested, allowed for a satisfactory adhesion when not contaminated or when the adhesive is reapplied.

CONCLUSION

Blood contamination affects the microtensile bond strength of self-etch adhesive to dentin. In addition, none of the decontamination procedures used in this study restored the bond strength. Hence, in a clinical scenario, if blood contamination occurs, thorough cleaning and rinsing followed by repeating the bonding procedure are recommended. In addition to this, alternative materials should be considered for restoration, if blood contamination cannot be avoided.
Within the limitations of this in vitro study, it can be concluded that blood contamination should be avoided when using self-etch adhesives.

REFERENCES