Effect of hemostatic agent on microshear bond strength of total-etch and self-etch adhesive systems

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ABSTRACT

Background: Application of hemostatic agents can negatively affect the bond strength of adhesive systems to dental substrate. This study aimed to assess the effect of ferric sulfate on microshear bond strength of four total- and self-etch adhesive systems to dentin after water storage.

Materials and Methods: In this in vitro study, 192 dentin slices with 2 mm thickness were made of 64 extracted sound human third molars. The samples were divided into 8 groups (n = 24) as follows: G1: Scotchbond Multi-Purpose, G2: hemostatic agent + Scotchbond, G3: Adper Single Bond, G4: hemostatic agent + Adper, G5: Clearfil SE Bond, G6: hemostatic agent + Clearfil, G7: Single Bond Universal, and G8: hemostatic agent + Single Bond Universal. Composite cylinders with 0.7 mm diameter and 1 mm height were bonded to the surfaces. Each group was then divided into two subgroups (n = 12) for water storage for 24 h and 3 months. The microshear bond strength was then measured. Data were analyzed using the Shapiro–Wilk test, three-way ANOVA, one-way ANOVA, and Tukey’s test (P < 0.05).

Results: Application of ferric sulfate decreased the bond strength of all bonding agents after both 24 h and 3 months of storage; but, this reduction was not statistically significant (P > 0.05). Single Bond Universal at 24 h showed the highest and Adper Single Bond at 3 months showed the lowest bond strength (P < 0.001).

Conclusion: Dentin contamination with hemostatic agents negatively affects the bond strength of total- and self-etch adhesives.

Key Words: Adhesives, hemostatics, shear strength

INTRODUCTION

The demand for tooth-colored restorations is increasing worldwide.[1] Appropriate isolation is among the most important factors determining the success and durability of composite restorations.[2] Adequate isolation is particularly important at the gingival margins of restorations.[2] In other words, to achieve maximum durability of composite restorations, contamination of surfaces with blood or gingival crevicular fluid should be prevented[2] because contamination of surfaces with blood or saliva decreases the resin bond strength to dentin in both total- and self-etch adhesive systems.[3-6] Resin bonding to contaminated surfaces can cause microleakage at the restoration margins.

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and subsequent development of secondary caries and restoration failure.\cite{7} Proteins, platelets, and macromolecules present in blood form a layer on dentin due to the affinity of dentin for proteins, which prevents resin penetration into dentin.\cite{8,9} This can decrease the bond strength to dentin by 30%–70%.\cite{10}

One commonly used technique to control bleeding during tooth restoration is the use of hemostatic agents. Hemostatic agents are hydrophilic and acidic.\cite{11} They remove the smear layer and demineralize dentin.\cite{12} Ferric sulfate is among the commonly used hemostatic agents. Application of ferric sulfate may cause changes in the morphology and properties of dentin and the smear layer.\cite{13} Controversy exists regarding the effects of hemostatic agents on the resin to dentin bond strength; however, the majority of studies on this topic have pointed to the negative effects of hemostatic agents on bond strength.\cite{14-16}

This study aimed to assess the effect of ferric sulfate hemostatic agent on bond strength of four total- and self-etch adhesive systems. The null hypothesis was that ferric sulfate would have no significant effect on the bond strength of the adhesive systems to dentin.

**MATERIALS AND METHODS**

This *in vitro*, cross-sectional study was performed on 64 selected sound human mandibular third molars with no cracks or caries extracted within the past 1 month. The study was approved by the Ethics Committee of Islamic Azad University, Dental Faculty, Tehran (No# 179). The teeth were rinsed and immersed in 0.5% chloramine T solution (Fisher Chemical, Fair Lawn, NJ, USA) for 24 h. The teeth were longitudinally sectioned into dentin slices with 2 mm thickness. The bonding surface of each slice was polished using 600-grit silicon carbide paper for 1 min under water coolant to obtain a standard smear layer. After rinsing, the samples were randomly divided into 8 groups (n = 24) according to the type of bonding agent and use of hemostatic agent (Astringedent; Ultradent Product Inc., Utah, USA) as follows. Table 1 shows the composition of bonding agents used.

- **Group 1**: The surface was etched with 37% phosphoric acid for 15 s and rinsed for 30 s. Excess water was removed using a cotton pellet such that the surface remained moist. Scotchbond multipurpose primer was then applied on the surface and dried with gentle air spray. Bonding agent was then applied on the surface
- **Group 2**: Astringedent hemostatic agent was applied on the surface for 60 s followed by 60 s of rinsing. The remaining steps were performed as in Group 1
- **Group 3**: The surface was etched with 37% phosphoric acid for 15 s followed by 30 s of rinsing. Excess water was dried by a cotton pellet such that the surface remained moist. Adper Single Bond was then applied over the surface for 15 s and dried with gentle air spray for 5 s
- **Group 4**: Astringedent hemostatic agent was applied on the surface for 60 s followed by 60 s of rinsing. The remaining steps were performed as in Group 3
- **Group 5**: Clearfil SE Bond primer was applied on the surface, allowed 20 s, and dried with gentle air spray. The bonding agent was then applied over the surface for 15 s and dried with gentle air spray
- **Group 6**: Astringedent hemostatic agent was applied on the surface for 60 s followed by 60 s of rinsing. The remaining steps were performed as in Group 5
- **Group 7**: Single Bond Universal was applied on the surface for 35 s and thinned with gentle air spray for 10 s
- **Group 8**: Astringedent hemostatic agent was applied on the surface for 60 s followed by 60 s of

| Table 1: Materials used in this study |
|------------------|--------------|--------------|
| **Adhesive systems** | **Composition** | **Manufacturer** |
| Adper Scotchbond multi-purpose | Primer: HEMA, polyalkenoic acid polymer, water | 3M, ESPE, St Paul, MN, USA |
| Adper single bond | Bonding: Bis-GMA, HEMA, tertiary amines, photoinitiator | 3M, ESPE, St Paul, MN, USA |
| Clearfil SE bond | Bis-GMA, HEMA, dimethacrylates, polyalkenoic acid copolymer, initiators, water and ethanol | Kuraray, Okayama, Japan |
| Single Bond Universal | Primer: MDP, HEMA, dimethacrylate Monomer, water, catalyst Bond: MDP, HEMA, dimethacrylate Monomer, microfiller, catalyst | 3M, ESPE, St Paul, MN, USA |

SE: Standard error
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In all groups, adhesive was light-cured using a light-emitting diode light-curing unit (Demetron LC; Kerr, Orange, CA, USA) with an intensity of 600 mW/cm². Cylindrical plastic molds with an internal diameter of 0.7 mm and 1 mm height were then mounted on the surface and filled with A2 shade of Z250 composite (3M ESPE, St. Paul, MN, USA). Composite resin was light cured for 40 s. Samples in each group were then randomly divided into two subgroups (n = 12) for measurement of microshear bond strength after 24 h and 3 months of storage in distilled water at 37°C. The microshear bond strength was measured in a universal testing machine (M350-10CT Testometric, Lancashire, United Kingdom) at a crosshead speed of 0.5 mm/min until debonding. The bond strength was recorded in megapascals (MPa). Data were analyzed using the Shapiro–Wilk test, three-way ANOVA, one-way ANOVA, and Tukey’s test via SPSS version 22.0 (SPSS Inc., IL, USA) at 0.05 level of significance.

RESULTS

Table 2 shows the mean and standard deviation of microshear bond strength in different groups. Type of bonding agent had a significant effect on bond strength (P = 0.045) such that the bond strength of Single Bond Universal was averagely 3.40 MPa higher than that of Scotchbond (P = 0.019) and 3.69 MPa higher than that of Adper Single Bond (P = 0.011).

Application of Astringedent hemostatic agent decreased the bond strength at both 24 h and 3 months. However, the effect of use/no use of Astringedent hemostatic agent and duration of water storage were not significant on bond strength (P > 0.05). The interaction effect of type of bonding agent and storage time on bond strength was statistically significant (P < 0.001) such that Single Bond Universal after 24 h of water storage (24.01 ± 1.58 MPa) and Clearfil SE Bond after 24 h of water storage (23.36 ± 1.66) yielded the highest bond strength and Adper Single Bond after 3 months of water storage (15.12 ± 1.24 MPa) and Clearfil SE Bond after 3 months of water storage (16.93 ± 0.87 MPa) yielded the lowest bond strength.

DISCUSSION

Most hemostatic agents are hydrophilic and acidic and can cause contamination of bonding surfaces. They can also demineralize dentin and affect the hybrid layer formed by different adhesive systems and as a result affect the bond strength of adhesive systems to tooth structure. The current results confirmed the null hypothesis regarding no significant effect of Astringedent hemostatic agent on bond strength since the reduction in bond strength was not significant in any of the total- or self-etch adhesive systems at any time point. In contrast to our findings, Arslan et al. reported a significant reduction in bond strength of total- and self-etch adhesive systems following the use of hemostatic agent.

Astringedent is a hemostatic agent containing 15.5% ferric sulfate (Fe₂(SO₄)). It is a hydrophilic solution with acidic properties (pH = 1), which can modify the dentin surface, hybrid layer, and smear layer in the etching and bonding process. Ferric sulfate can also cause coagulation of the organic collagen matrix or plasma matrix proteins in dentinal tubules, which can explain the reduction in bond strength to dentin following the use of this hemostatic agent. Kuphasuk et al. showed that the reduction in bond strength of the total-etch adhesive to dental substrate following the application of hemostatic agent was not significant, which was in agreement with our results. Many studies have reported significant reduction of bond strength of self-etch adhesives as the result of application of hemostatic agents. In the present
study, the bond strength of self-etch adhesives decreased following the application of ferric sulfate; however, this reduction was not significant. Such a controversy in the results may be attributed to different methodologies, sample preparation, and assessment of bond strength.

According to Ayo-Yusuf et al., contamination of dentin surfaces with hemostatic agents changes the properties and morphology of dentin. They also demonstrated that dissolution of dentin smear layer following the application of hemostatic agents results in occlusion of dentinal tubules and formation of granular deposits, which remain even after acid etching and can decrease the bond strength of total-etch adhesives. However, this reduction in bond strength was not significant in our study because phosphoric acid can demineralize dentin due to its high acidity (pH = 0.5). Phosphoric acid also might degrade ferric sulfate. On the other hand, self-etch adhesives cannot cause adequate demineralization of dentin following the application of hemostatic agents due to their low acidity, which can decrease the bond strength. Insignificant reduction in bond strength of self-etch adhesives in this study following the application of ferric sulfate can be attributed to the presence of 10-Methacryloyloxydecyl dihydrogen phosphate (MDP) in the composition of these adhesives and formation of chemical bonds by the MDP.

In our study, the mean bond strength of Single Bond Universal was significantly higher than that of Scotchbond and Adper Single Bond. Anil et al. demonstrated that total-etch adhesives have higher technical sensitivity due to their higher clinical procedural steps and there is a risk of inadequate dentin surface moisture following rinsing and drying or contamination of bonding surfaces and consequent reduction in bond strength. On the other hand, Yoshida et al. indicated that the chemical bonds between MDP present in the composition of Single Bond Universal and tooth hydroxyapatite increase the bond strength.

Since the present study aimed to assess the effect of contamination of dentin surface with ferric sulfate on bond strength without stress application, the samples were not subjected to thermocycling. If thermocycling is performed, it increases the generalizability of results to the oral condition.

The current findings enhance the knowledge of clinicians regarding the effects of hemostatic agents on the quality of bonding of adhesives to dentin. Further studies are required to assess the efficacy of certain materials to decontaminate the surface from hemostatic agents.

CONCLUSION

Within the limitations of this in vitro study, the results showed that contamination of dentin surface with hemostatic agents could negatively affect the bond strength of total- and self-etch adhesives.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

REFERENCES


