Comparative evaluation of different surface treatments of the salivary contaminated dentin on the shear bond strength of self-etch adhesives: An in vitro study

Himanshi Tehlan, Ashima Garg
Department of Conservative Dentistry and Endodontics, Sudha Rustagi College of Dental Sciences and Research, Faridabad, Haryana, India

Abstract
Aims and Objectives: This study aimed to evaluate and compare the effect of different surface treatments of the salivary contaminated dentin on the shear bond strength of one-step self-etch adhesives.

Materials and Methods: The coronal buccal surfaces of 50 human mandibular molars were ground to expose dentin. The specimens were randomly divided into five groups. Ten teeth were left uncontaminated and served as control group. Rest of the teeth were then divided based on the decontamination method used as follows: Group II (no decontamination done), Group III (decontamination with rinsing), and Group IV (decontamination with etching), Group V (decontamination with ethanol). Composite resin cylinders of 4 mm diameter and 4 mm length were fabricated on the surfaces. Shear bond strength testing was done in a universal testing machine, and the data were subjected to a one-way analysis of variance and Kruskal-Wallis test. Intergroup comparison was made using Mann-Whitney U-test.

Results: The highest bond strength was seen in Group 1, followed by and least in Group II. The difference was found to be statistically significant among all the groups. Group II and Group IV showed lower shear bond strength than Group I (control) and Group III (P < 0.05). The intergroup comparison shows significant differences between Group I with all the other groups.

Conclusion: It was concluded that the use of decontaminant improved the bond strength to salivary contaminated dentin in self-etch adhesives.

Keywords: Composite resin; decontamination; dentin; salivary contamination; self-etch adhesives; shear bond strength

INTRODUCTION
Isolation is one of the most important factors for ensuring the adhesion of the composite resin to dentin as contamination encountered during bonding procedures can lead to reduction in the bond strength. Moisture such as gingival fluid, blood, and in particular saliva, can affect the quality of the bond, leading to microleakage at the tooth restoration interface which may result in the loss of restoration, recurrent caries, postoperative sensitivity, and discoloration. Etch and rinse or total-etch adhesive being a multistep process requires separate acid etching, and chances of contamination are more likely due to the increased number of application steps.

Whereas self-etch adhesive system increases user’s reliability with decreased number of application steps and

Access this article online
Quick Response Code:
Website: www.jcd.org.in
DOI: 10.4103/jcd.jcd_262_22

How to cite this article: Tehlan H, Garg A. Comparative evaluation of different surface treatments of the salivary contaminated dentin on the shear bond strength of self-etch adhesives: An in vitro study. J Conserv Dent 2022;25:436-9.
components.[3] Collapse of the air-dried, demineralized collagen is prevented as the smear layer-retained dentin, is simultaneously demineralized and polymerized in situ.[2] Even though these dentin adhesive systems are easier to use and less technique sensitive, salivary contamination may still occur during bonding procedures that can result in reduced bond strength and marginal seal. The decontamination methods and treatment protocols reported in the past to restore the bonding of the adhesive to dentin have shown varied results.

As simplified adhesives are widely being used nowadays, so the study was designed to evaluate the effect of different methods of decontamination on salivary contaminated dentin. In this study, ethanol and etching were used for decontamination of the contaminated dentin surface after curing the applied adhesive. Ethanol has been known to be a good solvent so it can dissolve and remove the surface glycoprotein layer. Etching is generally not used before self-etch adhesives, but etching with phosphoric acid may remove the salivary-contaminated layer and restores the bond strength. As not much literature is available, using ethanol and etchant as decontamination methods with self-etch adhesives. Hence, this study was designed to evaluate the effect of different surface treatments of the salivary contaminated dentin on the shear bond strength of self-etch adhesives

**MATERIALS AND METHODS**

A total of 50 mandibular intact posterior teeth extracted for periodontal or orthodontic reasons were selected. The teeth were embedded parallel to their long axis into self-cure acrylic resin with 2/3 of radicular length in acrylic. Enamel from the buccal surface was reduced to create a flat dentin surface using straight fissure bur in high-speed handpiece. After drying of excess moisture from all the teeth, two coats of one-step self-etch adhesive were applied on the cervical third of the prepared dentin surface using a microbrush tip and cured for 15 s using an LED curing light source. Out of 50 teeth, 10 teeth were not contaminated (Group I), in which composite was placed on the cured adhesive without any contamination. Contamination of the remaining 40 teeth was done using unstimulated freshly derived human saliva which was gently agitated on the prepared dentinal surface with an applicator tip and was left undisturbed for 20 s. The teeth were then divided based on the decontamination method used: Group II: no decontamination was done where the saliva layer on the cured adhesive was blown with air and dried. Group III: decontamination with rinsing where the contaminated surface was rinsed with water, dried and adhesive was applied again and cured, Group IV: decontamination with etching: after rinsing and drying, etching was carried out for 5 s with 37% phosphoric acid. The etchant was washed, and the surface was blot dried, followed by adhesive reapplication and curing, and Group V: decontamination with ethanol: where the surface was rinsed and cleaned with ethanol, followed by re-application of adhesive. In all the groups for composite placement, a transparent cylindrical matrix of 4 mm inner diameter and 4 mm length was placed to hold the composite resin to dentincomposite interface. The composite was placed and light-cured in increments for 40 s.

The prepared specimen was subsequently stored in 100% relative humidity for 24 h. Then, all the teeth were subjected to thermocycling for 1000 cycles at 5°C and 55°C.

Shear bond strength at dentincomposite interface was calculated using a universal testing machine (UTM) at crosshead speed of 1 mm/min. The load was applied using a knife-edge blade until failure occurred. The bond strength at breaking load was calculated, and the results obtained were statistically analyzed.

**RESULTS**

Shear bond strength of all specimens was determined using UTM, and load at dentincomposite interface was recorded, tabulated, and statistically analyzed using SPSS version 21.0 (IBM COMPANY, NY, USA).

Table 1 shows the mean bond strength and comparison between the five experimental groups. The bond strength was compared using the Kruskal-Wallis test. The highest bond strength was seen in Group I, followed by Group V > Group IV > Group III > Group II [Figure 1].

Table 2 shows post hoc comparison, using Mann-Whitney U-test. The intergroup comparison shows significant differences between Group I with all the other groups. Among all the decontamination groups, the bond strength was significantly higher for Group V as compared to

---

**Table 1: Comparison of mean bond strength and standard deviation among five groups**

| Group          | Mean   | SD    | 95% lower bound | 95% upper bound | χ²   | P      |
|----------------|--------|-------|-----------------|-----------------|------|--------|
| Group I: Positive control | 393.300 | 86.6376 | 331.323 | 455.277 | 26.389 | 0.0001* |
| Group II: Negative control | 143.670 | 13.8390 | 133.770 | 153.570 | 208.831 | 0.00001* |
| Group III: D+ rinsing | 161.330 | 66.4023 | 113.829 | 208.831 | 236.517 | 0.00001* |
| Group IV: D+ etching | 180.400 | 78.4469 | 124.283 | 217.138 | 165.342 | 0.0001* |
| Group V: D+ ethanol | 191.240 | 36.2025 | 165.342 | 217.138 | 180.300 | 0.0001* |

*Statistically significant. Kruskal-Wallis test, level of significance set at P<0.05. SD: Standard deviation
Group II. No significant differences in bond strength were seen among Groups V, IV, and III. Furthermore, Group II showed nonsignificant difference from Group III to Group IV.

**DISCUSSION**

A clean substrate surface, free of any contaminants is a prerequisite to achieving good adhesion and higher bond strength. Saliva contamination during restorative procedures can compromise the bonding. Saliva consists mainly of water, macromolecules, electrolytes, and organic particles. The water present in the saliva, as well as the salivary glycoproteins, has been pointed out as the main factors for the reduction of the adhesion to dentin.\([3]\)

Hence, if contamination happens, decontamination should be carried out to restore the bond strength.

The decontamination protocol may vary for total-etch and self-etch. For total-etch, retching for 5 s has been the standard protocol. For self-etch group, still, no protocol has been standardized. Various studies done to date have reported variable results. Even few studies\([4,5]\) have reported that the saliva contamination of dentin had no adverse effect on the bonding efficiency of one-bottle adhesive systems while others have shown that the saliva contamination of the dentin surface produced a significant decrease in the bond strength.\([6-11]\)

An ethanol-based self-etch adhesive Tetric N-Bond (Ivoclar Vivadent) was used in this study. It contains low levels of acidic monomer and is therefore “mild-etching” adhesives with a pH of approximately 2.5–3.0. It is based on a combination of monomers of hydrophilic (hydroxyethyl methacrylate), hydrophobic (decanediol dimethacrylate), and intermediate (bis-GMA) nature.

For decontamination, etching and ethanol were used in this study. Etching is generally not done on dentin before self-etch adhesives, but it was used in this study as phosphoric acid possibly may remove the salivary contaminated layer and restore the bond strength to dentin. Ethanol was used as it is a known good solvent and it can dissolve and removes the surface glycoprotein layer from the salivary contaminated dentin.\([12]\)

The highest shear bond strength was seen in Group I which was the uncontaminated group and the lowest bond strength was seen in the contaminated group. The results are in accordance with many other studies that showed that contamination of the bonded surface after curing of the self-etch adhesive results in lower bond strength.\([6,7,9-11,13]\)

The reason can be explained by the physical barrier caused by the impregnation of salivary gycoproteins in the adhesive layer, which is poorly polymerized due to inhibition by oxygen. The contaminated layer acts as a semipermeable membrane after polymerization which causes decrease in the bond strength.\([9]\)

Contrarily to the result of the present study, Gupta *et al.*\([5]\) in their study reported that saliva contamination had no effect in self-etch adhesives. The varied results from our study could be attributed to the difference in the self-etch adhesives used. In their study, Single Bond Universal (one-bottle adhesive) was used which contains ethanol as well as methacryloyloxydecyl dihydrogen phosphate (MDP) monomers which have been found to decrease the susceptibility to hydrolysis, so it does not get affected by saliva contamination. The self-etch adhesives used in our study do not have MDP in its composition.

In our study, in all the decontamination protocol groups, the highest bond strength was seen in group where ethanol was used as a decontaminant. Ethanol promotes a greater dispersion of water and has disinfectant properties which could be advantageous for the decontamination of a surface contaminated with saliva promoting superior adhesive forces. Ethanol also reduces the surface tension of...
water present in the saliva and allows the spreading of the mixture along the surfaces that are coated with water.\[14\]

This could be the reason for improved bond strength after using ethanol as a decontaminant in the present study. Our results are in agreement with a study by Yaman et al.\[2\] who found improvement in the bond strength of fiber post to salivary contaminated dentin when ethanol was used as a cleansing protocol. No study with contrarily results was found in the literature.

In the present study, decontamination with etching also improved the shear bond strength comparable to ethanol. Reetching in total-etch adhesives after salivary contamination has been shown to increase the bond strength to dentin,\[3\] but its role as decontaminant in self-etch adhesives is still not established. In the present study, the use of etching as decontaminant after salivary contamination has been shown to increase the bond strength. The results are in agreement with studies done by Furuse et al.\[15\] and Haralur et al.,\[6\] who reported that reetching of a cured contaminated adhesive, eliminated the contaminant residue and removed the adhesive coating.\[16\]

Results of the study showed that decontamination with water rinsing though improved the bond strength but their difference was insignificant from the contaminated group. Furthermore, nonsignificant difference was observed from the group, in which etchant and ethanol were used. Literature has shown mixed results for the bond strength when the contaminated layer is rinsed after curing the self-etch adhesives. Studies by Kulkarni et al.\[17\] and Ülker et al. (2017)\[18\] have found a significant increase in the bond strength after rinsing and drying the contaminated layer before bonding. Contrarily, Fritz et al.\[10\] hypothesized that if saliva contamination occurred after the adhesive already was polymerized and the operator intervened by rinsing and drying the preparation by additional adhesive after rinsing, then a collapsed zone of resin-deprived collagen could result which result in decreased bond strength. They assumed that not all of the resin in the interstices of the collagen mesh will be polymerized. The addition of more resin likely would not penetrate this altered collagen surface completely, thereby decreasing the bond strength. In our study, milder self-etch adhesives with pH of 2.5–3.0 were used, so weaker acid and the presence of remnant water may have resulted in lower bond strength.

The present study has certain limitations as salivary contamination and decontamination were done after the adhesive was cured. As contamination can happen at different steps during restoration, more studies are required to evaluate the effect on bond strength after using the different cleansing protocols at various stages of contamination.

**CONCLUSION**

Within the limitation of this study, it can be concluded that salivary contamination decreases the bond strength in self-etch adhesive. All the decontamination treatment protocols used, increased the bond strength to dentin. The highest bond strength was seen in group where ethanol was used followed by etching and the least in the group where water rinsing was done.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**

1. Yoo HM, Oh TS, Pereira PN. Effect of saliva contamination on the microshear bond strength of one-step self-etching adhesive systems to dentin. Oper Dent 2006;31:127-34.
2. Yaman BC, Ozer F, Takeci T, Karabacak B, Koray F, Blatz MB. Effect of thermomechanical aging on bond strength and interface morphology of glass fiber and zirconia posts bonded with a self-etch adhesive and a self-etch resin cement to natural teeth. J Prosthodont 2014;11:455-64.
3. Kim Y, Kim S, Jeong T, Son SA, Kim J. Effects of additional acid etching on the tensile bond strength of different generation adhesive systems. An in-vitro study. J Clin Diagn Res 2015;9:C91-4.
4. Haralur SB, Alharthi SM, Aboschel SA, Alqantani KM. Effect of decontamination treatments on micro-shear bond strength between blood-saliva-contaminated post-etched dentin substrate and composite resin. Healthcare (Basel) 2019;7:E128.
5. Koppolu M, Gogala D, Nalluru S. Effect of saliva and blood contamination on the bond strength of the self-etching adhesive system – An in vitro study. J Conserv Dent 2012;15:270-3.
6. Salivo LA, Sinhoretti MA, Sobrinho LC, Consani S, Konno AN. Bond strength of adhesive systems to saliva-contaminated dentin. Braz J Oral Sci 2004;3:404-8.
7. Chasqueria FA, Luis J, Portugal J. Effect of saliva decontamination protocol on the adhesion to dentin with a universal adhesive. Med Dent Cir Maxilofac 2019;60:51-8.
8. Fritz UB, Finger WJ, Stein H. Salivary contamination during bonding procedures with a one-bottle adhesive system. Quintessence Int 1998;29:567-72.
9. Hitmi L, Attai JP, Degrange M. Influence of the time-point of salivary contamination on dentin shear bond strength of 3 dentin adhesive systems. J Adhes Dent 1999;1:219-32.
10. Munaga S, Chitumalla R, Kubigir SK, Rawtiya M, Khan S, Sajan P. Effect of saliva contamination on the shear bond strength of a new self-etch adhesive system to dentin. J Conserv Dent 2014;17:31-4.
11. Ülker E, Bilgin S, Kahvecioglu F, Erkan Al. Effect of saliva decontamination procedures on shear bond strength of a one-step adhesive system. Niger J Clin Pract 2017;20:1201-5.
12. Kewlani M, Saha SG, Bhardwaj A, Saha MK, Vijaywargiya P, Jain S, et al. Comparative evaluation of the effect of decontamination protocol on the shear bond strength of eighth generation bonding agent to contaminated dentin: An in vitro study. Med Pharm Rep 2020;93:287-91.
13. Furuse AY, da Cunha LF, Benetti AR, Mondelli J. Bond strength of resin-resin interfaces contaminated with saliva and submitted to different surface treatments. J Appl Oral Sci 2007;15:501-5.
14. Prasansuttiporn T, Nakajima M, Foxton RM, Tagami J. Scrubbing effect of self-etching adhesives on bond strength to NaOCl-treated dentin. J Adhes Dent 2012;14:121-7.
15. Kulkarni AS, Kotate S, Hegde V, Fanibunda U. The effect of saliva contamination on shear bond strength of two universal bonding agents – An in vitro study. J Clin Diagn Res 2018;12:ZC06-10.