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Original Article

Effect of different decontamination procedures from a saliva-contaminated cured bonding system (Single Bond)

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ABSTRACT

Background: A few studies have investigated the effect of saliva contamination of cured or uncured adhesive systems. The aim of this study was to compare the effect of different decontamination methods on the shear bond strength of composite to enamel and dentin using an adhesive contaminated after light activation.

Materials and Methods: In this *in vitro* experimental study, 80 extracted sound human teeth, 40 premolars and 40 central incisors were selected for dentin and enamel specimen preparation. Within each of the two test groups, the teeth were randomly subdivided into five groups. The materials used consisted of single bond (3M) and Z250 (3M). Except group 1 (Control), in Groups 2-5, cured adhesive was contaminated with saliva (20 s). Decontaminating procedures were rinsing, blot-drying, rebonding (Group 2), rinsing, air-drying, rebonding (Group 3), etching, rinsing, blot-drying, rebonding (Group 4) and etching, rinsing, blot-drying (Group 5). Then, composite resin was inserted on the treated surfaces and cured. The results were subjected to one-way ANOVA and Tukey honestly significant difference (HSD) tests.

Results: Group 5 (etching, rinsing, blot drying) resulted in significantly lower bond strength to both enamel and dentin surfaces in comparison with the other groups ($P < 0.05$).

Conclusion: When the adhesive was re-applied, all decontamination methods in this study seemed sufficient to decrease the adverse effect of saliva.

Key Words: Dentin bonding agents, saliva contamination, shear bond strength

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INTRODUCTION

Composite resins are technique-sensitive, and achieving good isolation is very important. Unfortunately, it is not possible to use rubber dam in all clinical cases and, when using cotton rolls during the bonding procedures, some kind of contamination may happen.[1,2] Studies related to bonding efficacy of the saliva-contaminated bonding system or different decontamination procedures are controversial. Several studies have suggested that "total etching single bottle adhesive systems" are less sensitive to contamination with saliva than previous generation bonding agents.[2-7] Others have reported that saliva contamination of dentin resulted in a reduction of shear bond strength.[8-11] In addition, saliva contamination did not show the same effect in different stages of the bonding process.[5,6,12,13] Controversial data have been reported regarding the effect of saliva contamination on the enamel and dentin bond strength of adhesives because it depends on the individual adhesive used and also because few studies have investigated the effect of saliva contamination on the bond strength of cured or uncured adhesive systems.[3,8-15] The aim of this study was to compare the effect of different treatments on the enamel and dentin bond strength of a single bottle adhesive contaminated after curing.

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MATERIALS AND METHODS

A random sample of 80 extracted human teeth, 40 premolars and 40 central incisors was selected. The teeth were cleaned from tissue remnants and stored in distilled water with thymol for 1 week and in distilled water until they were used (<6 months from extraction).

For the shear bond test to dentin, the premolar teeth were embedded in cylindrical molds with self-curing acrylic resin up to the cervical region. The occlusal surfaces of the teeth were reduced by a water-cooled model trimming wheel to create the flat dentin surfaces. The surfaces were then wet ground with 600 and 800 grit silicon carbide abrasive papers.

For bond strength testing on enamel, 40 incisors were embedded in epoxy resin with their labial surfaces facing the bottom of cylindrical rubber molds. Flat peripheral enamel surfaces were prepared by wet grinding on 600 and 800 grit silicon carbide paper.

Within each of the two test groups, the teeth were randomly subdivided into five groups of 10 teeth each [Figure 1].

The materials used consisted of 35% phosphoric acid (3M/ESPE, St Paul, MN, USA), a single bottle adhesive system, Single Bond (3M/ESPE) and a microhybride composite resin, Z250 (3M ESPE).

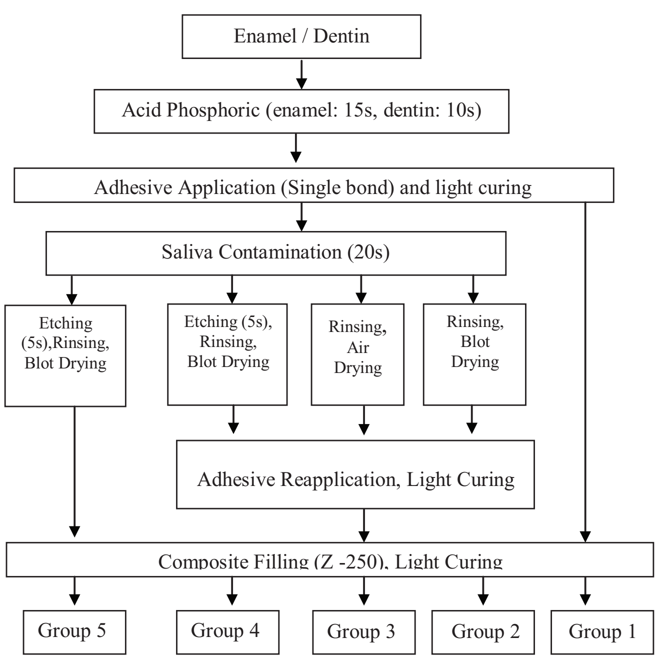

Figure 1: Schematic representation of the experimental design

The tested groups were prepared as follows:

Group 1: No contamination = Control
All the enamel and dentin surfaces were etched for 15 and 5s, respectively, and then washed vigorously with water. The excess water was removed using air until the enamel was chalky in appearance but the dentin was not desiccated. Application of Single Bond with a small saturated brush in two consecutive coats was followed by 5s of gentle air drying for removal of solvent and 20s light activation with a visible light curing unit, Optilux 500 (Demeton-Kerr, Orange, CA, USA). Then, the composite was inserted on its surface by a plastic cylindrical mold (2 mm height, 3 mm diameter) and cured for 40s from the top and bottom of the mold.

Group 2: The bonding procedure was carried out as in the control; however, the surface was contaminated with fresh saliva after light curing the adhesive and undisturbed for 20s. For contamination, 0.05 cc of fresh human saliva was used by a Hamilton syringe for 30s. Saliva was rinsed with a water stream from an air–water syringe for 20s and blot dried using cotton pellets. The bonding procedure was repeated and light cured and then composite was applied as in Group 1.

Group 3: Saliva was rinsed with a water stream from an air–water syringe for 20s and then gently air-dried with an air–water syringe from 10 cm distance. The adhesive was reapplied and light cured and then the composite was inserted.

Group 4: After contamination, the etching was reapplied for 5s. The surface was washed for 20s, blot dried and the adhesive reapplied. The adhesive was then light cured and the composite was inserted.

Group 5: Similar to Group 4, except that the adhesive was not used again and that the composite was inserted and then light cured.

Immediately after light curing, the specimens were stored in distilled water at room temperature for 48 h. Then, they were thermocycled for 2000 cycles in distilled water at 5 and 55°C (30s in each bath) and 10s between each bath.

Then, the samples were tested for shear bond strength. An Instron universal load testing machine (Zwick Z010; Zwich Gmbh & Co. KG, Ulm, Germany) with a crosshead speed of 1 mm/min was used to apply shear stress to the bonding interface. Shear bond strengths data were subjected to one-way ANOVA and Tukey

Table 1: Mean (SD) shear bond strengths (MPa)

Groups	Dentin	Enamel
	Mean (SD)	Mean (SD)
1*	16.05 (1.38)[a]	20.13 (3.04)[a]
2	17.05 (6.47)[a]	18.52 (2.18)[a]
3	18.14 (5.32)[a]	19.51 (4.21)[a]
4	16.72 (3.24)[a]	20.11 (5.03)[a]
5	8.32 (3.51)[b]	11.30 (1.09)[b]

Note: In each column, the same superscripts indicate no significantly different shear bond strength between the groups ($P < 0.05$). 1*: Control, 2: Decontaminated by rinsing, blot drying, re-bonding, 3: Rinsing, air drying, re-bonding, 4: Acid etching, rinsing, blot drying, re-bonding, 5: The same as Group 4 but without re-bonding

HSD tests.

The mode of failure was then examined by a stereomicroscope (SMZ 1500, Nikon, Kanagawa, Japan) with a magnification of ×40.

RESULTS

Table 1 summarizes the results of the shear bond strength determinations on enamel and dentin. When tested by ANOVA, significant differences were found within both the enamel and the dentin groups ($P < 0.05$). No significant differences were found within both the enamel and the dentin groups, except for Group 5 (decontaminated by etching, washing, blot drying and no reapplication of adhesive) with other groups.

After microscopic observation, failure modes were classified as (1) adhesive failure along the tooth–composite interface, (2) cohesive failure and (3) mixed failure.

In our study, failures in Groups 4 were mostly mixed, and all of the failures in Group 5 were adhesive.

DISCUSSION

Salivary contamination of the operating field is a frequent problem in restorative procedures, especially when rubber dam isolation is difficult or impossible, e.g. in deep cervical lesions, or when an indirect aesthetic restoration is seated.

In the present study, natural saliva was chosen as the contaminant because artificial saliva may confound the results. In addition, many studies have accepted whole healthy human saliva as an acceptable contaminating medium.[4-12] Fresh whole human saliva was provided by a healthy female who was instructed to restrain from eating and drinking 1-2 h before saliva collection.

Shear bond strength is a common method to evaluate the efficiency of dentin bonding.[3-11] It has been reported that if shear bond strength of composite to dentin and enamel ranges between 15 and 35 MPa, the bonding system is acceptable.[3,9]

In the present study, Group 5 showed a significantly lower bond strength in comparison with the other groups, which means that reapplication of bonding agent after cleaning the saliva is important for restoring bond strength. One possible explanation about this finding is decreased bonding thickness after removing the oxygen-inhibited layer by acid etching and rinsing.

Previous studies also showed this finding about some other bonding agents.[6,13,14,16-20]

Eirikson *et al.*[18] evaluated the effect of saliva contamination on microtensile bond strength between resin interfaces. After examination of different decontamination procedures, including "drying," "rinsing" or "using dentin bonding after drying or rinsing," they reported that the most reliable method for decontaminating saliva involves the application of adhesive.

Ari *et al.*[19] evaluated the effect of artificial saliva contamination on microtensile bond strength of Clearfil SE bond to the pulp chamber dentin. They applied the saliva on cured adhesive resin, rinsed, dried and re-treated with SE primer and SE bond, and reported no significant difference when compared with the control.

Yoo and others[6] evaluated the effect of saliva contamination and decontamination methods on the dentin bond strength of three "all-in-one" adhesives (One Up Bond F, Xeno III and Adper Prompt). For all adhesives, decontamination of contaminated cured adhesives by "washing and drying" resulted in the lowest bond strength. But, each of the two decontamination procedures, "slow drying" or "washing, drying and reapplication of adhesive," was acceptable. They related this result to removal of the adhesive layer during washing and drying, leaving a surface that was demineralized but non-infiltrated by monomers. Scanning electron microscopic evaluation also showed minimal resin infiltration on the fractured surface.

In the present study, no significant difference was seen between decontamination procedures in Groups 2 (rinsing, blot-drying, re-bonding), 3 (rinsing, air-drying, re-bonding) and 4 (etching, rinsing, blot-drying, re-bonding) with each others and with the control group.

Comparing treatment methods in Groups 3 and 4 showed that re-etching is not necessary when contamination of bonding surface with the saliva happens, and re-bonding followed by water rinsing and drying is sufficient. This result was in agreement with the study done by Bruchli *et al.*[20]

Also, comparing the treatment methods in Groups 2 and 3 indicates how dry (blot or air drying) the contaminated surface is after rinsing is not important. This finding of the present study is in agreement with the findings of previous studies.[19,20]

However, in contrast to the results of our study, Fritz *et al*.[11] reported that salivary contamination of the cured adhesive layer had a detrimental effect on bond strength. In their study, contaminated cured adhesive (an experimental one-bottle adhesive) was "rinsed and air dried" or "rinsed, air dried with additional adhesive application" (similar to Group 3 in our study) and, irrespective of the decontamination technique, shear bond strength was reduced to about 50% of the control values. Probable reasons for decreased bond strength in their study could be insufficient filling of collagen mesh with resin, greater ratio of unpolymerized (due to oxygen inhibition) to polymerized adhesive layer and difference in method and material. It has been reported that whenever the thickness of the adhesive layer is smaller than that of the oxygen inhibition layer, a significant portion of the top layers of the adhesive layer would be left unpolymerized.[21] It may be assumed that not all resin occupying the interstices of the collagen mesh is polymerized and is therefore easily removed during water rinsing. Then, air drying may result in a collapsed collagen network, deprived of resin. Reapplication of adhesive to this altered collagen surface will presumably not result in complete penetration. However, to understand the exact mechanism, further research is needed.

CONCLUSION

Under the circumstances of this study, it may be concluded that:

When saliva contamination occurred after light curing of Single Bond (3M), reapplying of adhesive followed by rinsing and air or blot drying is enough to restore shear bond strength. However, until further laboratory and clinical researches, any kind of contamination of the bonding area should be avoided.

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