Saliva Contaminated and Re-etched All-in-one Adhesive: Influence on Bond Strength

M.Khoroushi DDS*, B.Karimi DDS**

ABSTRACT

Introduction: In this study, we have investigated the effect of using phosphoric acid on bonding efficacy of an all-in-one adhesive system, after salivary Contamination of dentin.

Methods and Materials: Eighty-four extracted human molars were prepared for their superficial dentins to be exposed. The molars separated into 7 groups. Group 1 specimens were not contaminated. In groups 2-4, samples were contaminated with fresh human saliva after applying and before curing the adhesive (in group 2, adhesive was rinsed, in group 3, adhesive was not rinsed, and in group 4, after rinsing the adhesive, phosphoric acid was applied, and then rinsed). In groups 5-7, contamination was done after adhesive curing (in group 5, only rinsing, in group 6, rinsing, and adhesive reapplication, and in group 7, rinsing, using phosphoric acid, rinsing and adhesive reapplication. Shear bond strength was measured and analyzed.

Results: There were statistically significant differences between group means, except groups 3 and 5. Groups 1 and 4 demonstrated higher bond strength than other groups.

Discussion: Using phosphoric acid may be effective, provided that the contamination occurs prior to curing of the adhesive.

Key words: Saliva Contamination, All-in-one Adhesive, Dentin, Bond Strength.

[Dental Research Journal (Vol. 3, No.1, Spring - Summer 2006)]

Introduction

Preventing the restoration and from contamination by oral fluids is still a requirement for the dentistry in most of the clinical treatment methods [1].

All-in-one adhesives provide faster application and reduce number of components and application steps. But, for achieving the best results of bond strength, manufacturers recommend to applicate two, three, or more of these materials. So, the risk of saliva contamination in the field of operation has not been reduced [2-13].

In addition, the results of studies related to the bonding efficacy of saliva-contaminated dentin are not in agreement with each other [13-19].

Fritz et al (1998) reported 50% reduction in mean bond strength when composite resin was bonded directly to a saliva contaminated enamel and dentin [2].

In contrast, some other investigators found that saliva contamination of dentin did not affect the bond strength of dentin bonding agents [3, 4].

Some studies reported that re-etching of saliva contaminated enamel with phosphoric acid is the best method for obviating the negative effects of saliva [3, 4, 7].

The aim of this study was to investigate the effect of applying phosphoric acid on shear bond strength(sbs) of composite resin for saliva contaminated dentin before and after curing of an all-in-one adhesive system called i-Bond [20].

Methods and Materials

Eighty-four extracted sound human molars were stored in 0.2% thymol solution for a maximum time of 3 months for further processing in the laboratory. Teeth were mounted in cylindrical molds with self-curing acrylic resin up to their

*Assistant professpr, Department of Operative Dentistry, Faculty of Dentistry, Isfahan University of Medical Sciences, Isfahan, Iran.
**Dentist

cervical regions. The buccal surfaces of teeth were reduced on a water-cooled fissure bur (D+Z 008, Germany) and 600-grit silicon carbide paper to create flat dentin surfaces. Specimens were randomly divided in seven groups of 12 samples in each.

The i-Bond adhesive system (Heraeus-kulzer, Germany, Lot #010062) was used under several conditions. Three procedures (contamination; contamination and rinsing; contamination, rinsing and re-etching) using i-Bond adhesive system before and after light curing were evaluated. For contamination, 0.05cc of fresh human saliva was used by Hamilton syringe for 30 seconds.

The study groups were prepared as follow:

Group 1: In this group, application of i-Bond with a small saturated brush in three consecutive coats was followed by 5 seconds of gentle air drying to vaporize the solvent and remove excess water, and 20 seconds of light activation (Coltolux 2.5, C7906, Colten, USA).

Group 2: After applying the adhesive and before curing it, fresh whole saliva was applied and left undisturbed for 30 seconds. After 5 seconds of gentle air blast, the adhesive re-applied and cured.

Group 3: the procedure was the same as group 2, but after 30 seconds, contaminated surfaces were thoroughly rinsed for 15 seconds prior to blot drying and application of adhesive.

Group 4: the procedure was similar to group 3, but after blot drying, 37% H_3PO4 Was applied to the surface for 15 seconds and then was rinsed for 15 seconds and the blot was dried and the adhesive was applied as described previously.

Groups 5-7: In these groups dentin surfaces were contaminated after curing of the adhesive.

In group 5, without rinsing the saliva, 5 seconds of blot drying was done and composite resin was used.

In group 6, saliva rinsed for 15 seconds prior to blot drying and then the resin composite was applicated.

In group 7, the procedure was similar to group 6, except that the etching with 37% phosphoric acid was done after blot drying and rinsing was done thoroughly for 15 seconds. Then i-Bond adhesive system reapplied and cured. The procedures done for study groups are summarized in figure 1.

Clear plastic molds (3 mm wide and 5 mm high) were used slightly over filled with resin composite (Z100, 8004 A3, 3M-ESPE) and were placed firmly and carefully on dentin surfaces in all of the mentioned groups. Then, the light activation were used for 40 seconds from three sides of cylinders.

Specimens then stored in deionized water at 37°c for 24 hours. They were subjected to shear force in universal testing machine (DARTEC, HC 10) with a crosshead speed of 1mm/min until failure occurred.

Shear bond strength data were analyzed with ANOVA followed by Tukey's Honestly Significant Difference post hoc test to identify the differences.

Results

Results of one-way ANOVA comparing the shear bond strength values in Mpa on dentin are presented in table 1 and figure 1.

Among the groups, groups 1 and 4 demonstrated higher bond strength than either of the other 5 groups.

One-way ANOVA revealed that there were statistically significant differences between group means ($P<0.001$) except between groups 3 and 5 ($P=0.596$).

Duncan's multiple range comparison test located the sites of differences at $P<0.05$ which is summarized in table 2.

Generally, surface salivary contamination exhibited a statistically significant reduction in bond strength.

Discussion

Contamination of the operating field with inadvertent contact of blood or saliva is a frequent problem in dent addition, sometimes the application dam is difficult or even impossibl en deep cervical lesions are restored or when indirect restorations are seated. Thus, resin adhesives that bond effectively to dental substrates, in spite of protein contamination, would be highly desirable [1-6].

Table 1. Shear bond strength (Mpa) on dentin in different study groups (mean ± SD).

sbs (MPa)	Group 1 (n=12)	Group 2 (n=12)	Group 3 (n=12)	Group 4 (n=12)	Group 5 (n=12)	Group 6 (n=12)	Group 7 (n=12)
Minimum	13.44	9.20	12.73	15.28	12.73	6.36	6.79
Maximum	19.10	11.18	14.86	16.98	15.85	9.48	9.62
Mean value	15.06	9.84	13.84	16.12	14.02	7.73	8.58
SD	1.57	0.51	0.58	0.56	0.99	0.91	0.94

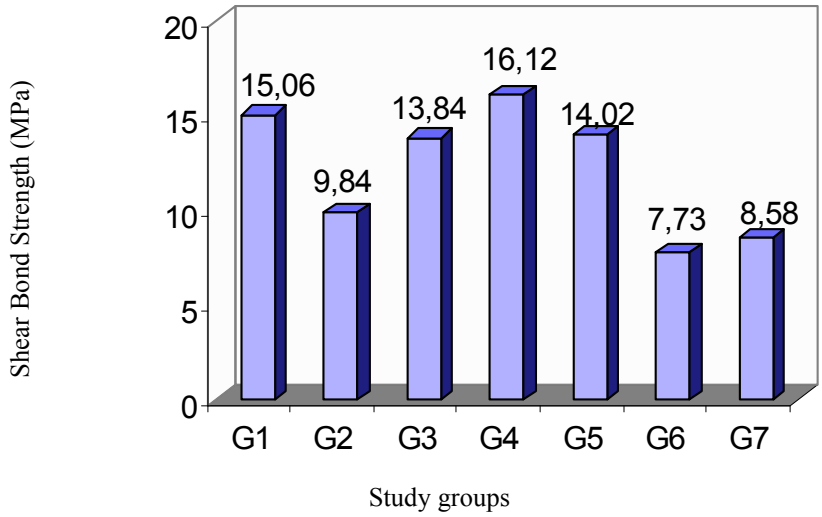

Figure 1. Means and ranges of the shear bond strength values for the study groups.

Table 2. The Comparison of each study group with the others.

	G2	*G3*	*G4*	*G5*	*G6*	*G7*
G1	*S*	*S*	*S*	*S*	*S*	*S*
G2		*S*	*S*	*S*	*S*	*S*
G3			*S*	*NS*	*S*	*S*
G4				*S*	*S*	*S*
G5					*S*	*S*
G6						*S*

Although in self-etching adhesive systems, all three basic steps including etching, priming, and applying adhesive, occur simultaneously, resulting in simplicity and time saving, most of systems should be applied two or more times to obtain enough thickness and adequate bond especially in dentinal substrates [7-11].

This study examined the shear bond strength to dentin of a one-bottle system, i-Bond, when contaminated with a measured amount of saliva at various stages in its application procedures.

In this study we used i-Bond adhesive system in which the recommended time of applying and curing for three layers is about 75 seconds, so, the contamination during application period is probable.

The main components of i-Bond system are 4-META and diurethandimethacrylate, HEMA and Glutaraldehyde. This system includes acetone and water as solvents. Applying 3 layers, start with enamel, leaving undisturbed for 30 seconds, gentle air flow until being no movement, additional drying until making glossy surface, and light curing for 20 seconds are manufacturer's instruction for this system.

The results of the present study on salivary contamination are in agreement with the findings of Hitmi et al (1999) and Fritz et al (1998). They had demonstrated that the newer generations of adhesive systems that use hydrophilic primers may be less sensitive to salivary contamination of prepared tooth surfaces than their previous generations. Self-etching adhesive systems simultaneously demineralize dentin while infiltrating it with monomers to the same depth, and then, they are polymerized in situ. Self-etching primer systems do not require the primer to be rinsed off after application. What happens to the acid is not still understood completely, but it is thought to be neutralized at some point by hydroxyl ions that are released from the hydroxyapatite during demineralization. The high buffering ability of the dentin should limit further demineralization of hydroxyapatite [2, 9, 13, 14.]

In this study, sbs in group 4 was more than other groups (16.12 Mpa). Perdiago et al (1997) revealed that when etchant and self-etch primer was used successively, etching patterns was more obvious than when self-etch primer was used singly [15].

In group 2, the specimens contaminated with saliva had mean bond strength of 9.84 Mpa which, Comparing with 15.06 Mpa for the Control group, it has a reduction of 33%. In the other hand, when the saliva on applied one-bottle adhesive air-dried, whether prior or after the curing of adhesive, sbs was reduced. Similar investigations had confirmed this results [2, 4, 13].

Air drying results in the collapse of water-filled collagen fibers and adsorption of dried protein film to the dentin surface. Both phenomena prevent penetration of the adhesive into the exposed collagen meshwork and, at last, cause formation of a sound hybrid layer [16, 17].

Saliva contamination of dentin after curing of adhesive and without additional rinsing (group 6) cause dramatically reduction in sbs. It is not surprising that adsorption of salivary glycoproteins make a film to the hydrophobic surface of dentin after curing of adhesive [18].

The present study has shown that salivary contamination of the adhesive after curing, would be removed by rinsing and drying (group 5), but using of H_3PO4 and rinsing prior to re-application of adhesive make a significant fall in sbs that has not been used in other studies. Rinsing and drying of saliva contamination is proposed as an accepted treatment to recover the sbs when contamination occurs after curing of adhesive. Also, Fritz et al suggested that the contaminated area must be removed by resurfacing the dentin with bur, which was not used in this study [2, 19].

According to the findings of this study, the best procedure for obviating the salivary contamination effect before curing of the adhesive (groups 2-4) was rinsing and blot drying followed by etching with phosphoric acid and reapplying the bonding system on the basic of manufacturer's instructions [20].

It seems that the use of phosphoric acid removes salivary contamination better and makes the dentin ready for more reliable bond.

Although it needs more investigation including SEM studies under circumstances of this study may be concluded that:

1- Contamination of the uncured i-Bond adhesive layer is simply removed by using phosphoric acid, rinsing, and reapplying of system.

2- After curing of adhesive, simple rinsing of saliva would be preferred. However, further corroborative researches must be accomplished.

3- Any kind of contamination of the bonding area should, in principle, be avoided.

References

1- Taskonak B, Sertgoz A. Shear bond strengths of saliva contaminated 'one-bottle' adhesives. J Oral Rehabil. 2002;29(6):559-64.

2- Fritz UB, Finger WJ, Stean H. Salivary contamination during bonding procedures with a one-bottle adhesive system. Quint Int. 1998;29(9):567-572.

3- Johnson ME, Burgess JO, Hermesch CB, Builema DJ. Saliva contamination of dentin bonding agents. Oper Dent. 1994;19(6):205-210.

4- Park JW, Lee KC. The influence of salivary contamination on shear bond strength of dentin adhesive systems. Oper Dent. 2004;29(4):437-442.

5- Xie J, Powers JM, McGuckin RS. In vitro bond strength of two adhesive to enamel and dentin under normal and contaminated conditions. Dent Mat. 1993;9(5):295-9.

6- el-Kalla IH, Garcia-Godoy F. Saliva contamination and bond strength of single-bottle adhesive to enamel and dentin. Am J Dent. 1997;10(2): 83-7.

7- Townsend RD, Dunn WJ. The effect of saliva contamination enamel and dentine using a self-etching adhesive. J Am Dent Assoc. 2004;135(7):895-901

8- Hansen EK, Munksguard EC. Saliva contamination vs. efficacy of dentin-bonding agents. Dent Mater. 1989;5(5):329-33.

9- Hitmi L, Attal JP, Degrange M. Influence of the time-point of salivary contamination on dentin shear bond strength of 3 dentin adhesive systems. J Adhesive Dent. 1999;1(3):219-232.

10- Hiraishi N, kitasako Y, Nikaido T, Nomura S, Burrow MF, Tagami J. Effect of artificial saliva contamination on PH value change and dentin bond strength. Dent Mater. 2003;19(5):429-34.

11- Milia E, Lallai MR, Garcia-Godoy F. In vivo effect of a self-etching primer on dentin. Am J Dent 1999;12(4): 167-171.

12- Roeder LB, Sichanthavony J, Powers JM. Bond strength of composite to contaminated dentin. J Dent Res 1997;76 [Abstract 423]

13- Nasciemento AML, Reis JIL, Fontana U. Effects of saliva contamination on shear bond strength to dentin. J Dent Res 1997;76:66-69 [Abstract 424]

14- Eliades G. Clinical relevance of the formulation and testing of dentin of dentin bonding systems. J Dent 1994;22 (2):73-81.

15- Gwinnett AJ. Altered tissue contribution to interfacial bond strength with acid conditioned dentin. Am J Dent 1994;7:243-6.

16- Barkmeier WW, Cooley RL. Laboratory evaluation of adhesive systems. Oper Dent 1992;(Suppl 5):50-61.

17- Van meerbeek B, Inoue S, Perdiago J. Enamel and dentin adhesion. In: Summit J, Robbins JW, Schwarts RS. Fundamental of operative dentistry. 2nd ed. Illinois: Quint publishing CO; 2001. p.191-4.

18- Perdiago J, Lambrechts P, van Meerbeek B, Tome AR, Vanherle G, Lopes AB. Morphological field emission-SEM study of the effect of six phosphoric acid etching agents on human dentin. Dent Mater 1996;12(4):262-71.

19- Abo T, Uno S, Sano H. Comparison of bonding efficacy of an all-in-one adhesive with a self-etching primer system. Eur J Oral sci 2004;112(3):286-92.

20- http://www.Heraeus-kulzer.com