

## Effect of Different Decontamination Procedures for Saliva-Contaminated Uncured Bonding Agent on Shear Bond Strength of Composite to Enamel

Hossein Afshar<sup>1</sup>, Shahram Mosharrafian<sup>2</sup>, Samaneh Abbasi Salimkandi<sup>3</sup>

<sup>1</sup> Associate Professor, Dental Research Center, Dentistry Research Institute, Tehran University of Medical Sciences, Department of Pediatric Dentistry, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

<sup>2</sup> Assistant Professor, Department of Pediatric Dentistry, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

<sup>3</sup> Postgraduate Student, Department of Periodontics, School of Dentistry, Yazd University of Medical Sciences, Yazd, Iran

### Abstract

**Background and Aim:** Prevention of contamination during the procedural steps is a requisite for achieving a satisfactory composite restoration. The aim of this experimental study was to assess the shear bond strength of composite to enamel following two different decontamination procedures of saliva-contaminated uncured bonding agent in comparison with uncontaminated condition.

**Materials and Methods:** Thirty-six extracted sound human premolars and incisors were selected. Enamel of the buccal surface was ground flat. The teeth were divided into 3 groups of 12 each. In the control group (1), 3M Single Bond adhesive was used according to the manufacturer's instructions, without any contamination. In groups 2 and 3 uncured adhesive was saliva contaminated and then: (group 2) rinsed, dried, etched (5 seconds), rinsed, dried and adhesive was reapplied and (group 3) cured, dried, etched (5 seconds), rinsed, dried and adhesive was reapplied. Then composite cylinders were bonded to the enamel surfaces. Finally, samples were sheared using Instron testing machine and shear bond strength data were subjected to one-way ANOVA.

**Results:** The mean bond strength was 16.5317 MPa in the control group, 16.2308 MPa in rinsed contaminated bonding group and 15.8025 MPa in cured contaminated bonding group. No statistically significant difference was found in the mean shear bond strength of groups 1, 2 and 3 ( $p=0.954$ ).

**Conclusion:** Both decontamination protocols (groups 2 and 3) resulted in acceptable bond strength and both were comparable with uncontaminated condition.

**Key Words:** Saliva contamination, Enamel, Shear bond strength, Bonding agent

✉ Corresponding author:  
Samaneh Abbasi Salimkandi,  
Postgraduate Student,  
Department of Periodontics,  
School of Dentistry, Yazd  
University of Medical Sciences,  
Yazd, Iran  
abbasi.samane@gmail.com

Received: 9 Dec 2013  
Accepted: 24 Nov 2014

➤ Cite this article as: Afshar H, Mosharrafian S, Abbasi Salimkandi S. Effect of Different Decontamination Procedures for Saliva-Contaminated Uncured Bonding Agent on Shear Bond Strength of Composite to Enamel. J Islam Dent Assoc Iran. 2015; 27(1):38-42.

### Introduction

Considering the high prevalence of caries and increased interest of patients and dentists in composite restorations, it is important to have adequate level of knowledge about the problems and complications of these treatments and methods to overcome them. The adhesive systems have technical sensitivity and are influenced by many factors. A prerequisite for obtaining successful results is complete isolation of the area and

prevention of contamination during the procedure. Using rubber dam is among the most effective strategies for prevention of contamination. If not used, contamination would be inevitable in many cases [1, 2]. In a clinical study, all CL II composite restorations restored without rubber dam isolation showed marginal leakage after 4-6 weeks [3]. If complete isolation cannot be achieved, non-bonded restorative materials must be necessarily used. Thus, the ability to isolate the area (with rubber

dam or cotton rolls) is the most important factor in selection of a restorative material. In a study in the United States, 63% of dentists reported never using a rubber dam for restorative procedures [4]. In cases where rubber dam cannot be used, cotton rolls must be necessarily used. However, use of cotton rolls is associated with high risk of contamination with the saliva, blood or gingival crevicular fluid when moving the cotton rolls, the lips or the tongue. This is a common problem encountered by dentists during composite restorations of teeth.

Several studies have assessed the effect of saliva contamination on bond strength of composite to tooth. However, the results are controversial depending on the bonding system and type of dental substrate (dentin or enamel). Although some studies have reported less susceptibility of new bonding systems to moisture contamination [5, 6], evidence shows that saliva contamination decreases the bond strength of composite to teeth [7-12].

Saliva contamination may occur at anytime during a restorative procedure. If contamination occurs after the application of bonding agent and prior to light curing, three strategies may be adopted: [1] the contaminated surface may be cleaned with a cotton pellet and bonding agent may be reapplied or [2] the surface can be washed, dried with a cotton pellet and the bonding agent can be reapplied, or [3] the surface can be acid etched, washed, dried with a cotton pellet and the bonding agent can be reapplied [13]. In a previous study, the contaminated surface was dried with a cotton pellet, the residual bonding agent on the surface was cured and the next steps were followed [14].

In case of inadequate bond strength, the restorative material may be lost and secondary caries, post-operative tooth hypersensitivity and marginal discoloration may occur [15].

Most previous studies have assessed contamination after enamel etching or dentin conditioning and studies on the effect of contamination after application of adhesive and prior to curing on bond strength are scarce. Also, many of the previous studies were conducted using multi-step dentin bonding agents [2, 5, 14].

This in-vitro study aimed to assess the effect of different decontamination methods for

saliva-contaminated uncured bonding agent on shear bond strength of composite to enamel.

## Materials and Methods

This in-vitro study was conducted on 18 premolar and 18 incisor teeth extracted for orthodontic, periodontal or prosthetic treatments. The teeth had to be free from caries, restorations, enamel defects (hypoplasia or use of forceps) and fractures since the aim of this study was to assess the composite resin bond to sound enamel. After washing and removal of tissue appendages, the teeth were immersed in 0.5% chloramine T solution and then stored in saline until the experiment (maximum of 6 months). For preparation of specimens, the premolar and incisor teeth were each randomly divided into three groups of 6 and then the 3 incisor and the 3 premolar groups were randomly combined in such way that eventually 3 groups of 12 teeth including 6 premolars and 6 incisors were created. Next, enamel of the buccal surface of the teeth was ground using a disc in such way that a plastic cylinder containing composite measuring 3mm in diameter and 3mm in height could be placed on the enamel surface. Next, the specimens were mounted in Acropars auto polymerizing acrylic resin (Marlic, Tehran, Iran) in molds (specific for Instron machine) up to the level of the cemento-enamel junction in such way that the composite-buccal surface interface was parallel to the lateral surfaces of the mold in order for the blade to apply load perpendicular and directly to the resin-tooth interface.

Next, the ground enamel surfaces were etched with 37% phosphoric acid (3M ESPE, St. Paul, MN, USA) for 15 seconds. Acid was applied to the surfaces and after 7 seconds, tapping was done by a disposable microbrush. The surfaces were rinsed for 10 seconds using water and air spray. To ensure that the pressure of water and air spray was equal for all specimens, the same dental unit was used and a barometer was installed in the path of water and air spray. Water spray pressure for all specimens was adjusted to be 2.8 kg/cm<sup>2</sup> and air pressure was adjusted to be 3.5 Psi bar.

In group 1, after rinsing, the surface was dried until a chalky white appearance was achieved (approximately 20 seconds). For drying, moisture- and oil-free air spray was used (ensured

by testing on a mirror). A disposable microbrush was used to apply Single Bond (3M ESPE, USA) to the etched and dried enamel surface in such way that the etched surface was saturated with the bonding agent. To uniform the thickness of the dentin bonding agent and to evaporate the organic solvent of dentin bonding agent, air was gently sprayed from 30 cm distance for 5 seconds.

Bonding agent was applied to the plastic mold and it was placed on the tooth surface and cured for 20 seconds. Distance from the tip of the Coltolux 75 light-curing unit (Coltene Whaledent, china) to the tooth surface was 1cm.

Clear plastic cylinders with an internal diameter of 3mm and height of 3mm were marked at 1.5mm distance from the top using a scalpel. These molds were prepared using the infusion tubes and used for the placement of composite (Z250 Filtek, 3M-ESPE, USA) on the surface. Composite was applied incrementally to the mold and cured. First, a 1.5mm-thick layer of composite was applied (up to the marked area) to the mold and light cured for 40 seconds at 1cm distance from the buccal surface. After curing, the plastic mold was cut with a scalpel and separated.

In group 2, 37% phosphoric acid was applied for 15 seconds, rinsed for 10 seconds and dried to achieve a chalky white appearance. Bonding agent was applied and contaminated with human saliva using a disposable microbrush soaked in human saliva (for each specimen, the microbrush soaked with saliva was swabbed on the surface for 4 times). After 10 seconds, the contaminated bonding agent was rinsed with water and air dried for 5 seconds from 5cm distance. The respective surface was dried for 5 seconds using air spray from 5cm distance. Next, 37% phosphoric acid was applied for 5 seconds and then rinsed for 10 seconds with water and air spray from 5cm distance and air-dried until a chalky white appearance was obtained. A layer of bonding agent was reapplied to the surface and subjected to gentle air spray for 5 seconds as in group 1.

Composite cylinder was placed on the surface as in group 1.

In group 3, all phases were done as in group 2.

After contamination of bonding agent, 10 seconds of time was allowed and the bonding agent was cured from 1cm distance for 20 seconds. Next, it

was dried with air spray from a 5cm distance for 5 seconds and acid etched for another 5 seconds followed by rinsing from 5cm distance with water spray and 10 seconds of drying with air spray until a chalky white appearance was achieved. It should be noted that the appearance of the dried surface was different from that in group 2. Re-application of bonding agent and placement of composite were done as in group 2.

Specimens were immersed in distilled water, incubated at 37°C for 24 hours and subjected to shear bond strength test in a universal testing machine at a crosshead speed of 0.5mm/min. The machine was calibrated prior to each cycle of testing. Simultaneous with load application, the respective curves were drawn by the machine on the display monitor connected to the machine and the load at failure (debonding) was recorded in Newton (N). The load in N was divided by the cross section of the composite block (mm<sup>2</sup>) to convert the strength values to MPa.

Data were analyzed using PASW version 18 software considering alpha=0.05 and the shear bond strength of composite to enamel was compared among the study groups using one-way ANOVA.

## Results

The results showed that the mean bond strength in the control group (no contamination, 16.53 MPa) was slightly greater than that in the two contaminated groups (16.23 and 15.80 MPa); however, this difference was not statistically significant and no significant difference was noted in shear bond strength of composite to enamel among different groups ( $p=0.954$ ) (Table 1).

## Discussion

Contamination of the preparation area commonly occurs during restorative treatments and controversy exists regarding the effect of contamination on bond strength. Measurement of shear bond strength is a common method for assessment of the efficacy of bond and 15-35 MPa bond strength values are clinically acceptable. This study evaluated the effect of saliva contamination on shear bond strength and it was demonstrated that contamination of uncured adhesive with saliva would have no negative effect on bond strength if

**Table 1.** Descriptive statistics of bond strength among the 3 groups of control and contaminated specimens

Group	Number of specimens	Minimum	Maximum	Mean	Standard deviation
<b>Control group bond strength</b>	12	6/27	29/98	16/5317	7/57606
<b>Bond strength of rinsed contaminated group</b>	12	8/83	25/07	16/2308	4/52928
<b>Bond strength of cured contaminated group</b>	12	10/00	24/26	15/8025	4/95785

cleaned with any of the methods used for groups 2 and 3.

It should be noted that selection of groups in this study was based on ambiguities in previous studies and this study aimed to elucidate the role of rinsing with water, drying, acid reapplication and also curing of the contaminated bonding agent, drying and re-application of acid in surface wettability by the bonding agent and the obtained bond strength. In this study, methods of decontamination that were logically inappropriate or had been refuted in previous studies [13-15] were not tested. Instead, the efficacy of reapplication of bonding agent was examined because its efficacy had been somehow confirmed in previous studies [13-15].

Salivary contamination of cured and uncured bonding agent has been evaluated in several studies and to better elucidate the effect of some factors, comparative similar studies are required.

Ghavam et al, in their study tested three strategies for decontamination of uncured bonding agent:

1. Drying the contaminated area with cotton pellets and curing the residual bonding agent on the surface

2. Rinsing, drying and reapplication of bonding agent as in group 2 of the current study. The only difference was that dentin was examined by Ghavam et al, and after rinsing, etching was not done.

3. Preparation and repetition of steps

Only group 1 in their study showed a reduction in bond strength compared to the control group. In their study, not rinsing the surface was suggested to be a possible reason for this reduction because salivary proteins prevent a close contact between the bonding agent and composite resin. Inadequate polymerization of bonding agent due to the presence of saliva or decreased thickness of

adhesive might have also played a role in this regard.

Only group 2 in the current study was similar to the second group in their study. The only difference was that they did not acid etch the contaminated bonding surface after rinsing. The bond strength in group 2 was not significantly different from that of the control group in both studies [14].

Darabi et al, in their study evaluated 80 incisor and premolar teeth. The composite to dentin bond strength was examined in 5 groups of 8 premolar teeth and the bond strength of composite to enamel was examined in 5 groups of 8 incisor teeth [13]. Group 3 in their study was almost similar to group 2 in our study. The only difference was that the duration of saliva contamination in their study was 20 seconds while this time was 10 seconds in the current study. They did not acid etch the contaminated bonding surface after rinsing, and drying was performed by a cotton pellet in their study (versus air spray in our study until obtaining a chalky white appearance). The bond strength value in this group was not significantly different from that of the control group in the two studies.

It appears that in case of contamination, resin surface is covered with a layer of salivary glycoproteins preventing adequate contact between the two bonding surfaces. Thus, a reduction in bond strength is expected when using methods of decontamination where salivary glycoproteins are not eliminated. However, in groups 2 and 3 in the current study, acid was used (prior or after curing) to eliminate salivary glycoproteins and to prepare the surface for application of bonding agent. Thus, bond strength values close to ideal are expected with no significant difference with the control groups. As expected, the mean bond strength in the

3 groups in our study was not significantly different from that in the control group.

Data dispersion in the 3 groups in our study may be attributed to enamel surface preparation and type of tooth (premolar or incisor). Considering the different morphology of incisor and premolar teeth, different preparations are required to achieve a smooth surface for placement of the composite cylinder. This may change the thickness or even surface area of the bonded enamel in different specimens. However, since the distribution of specimens was similar in the 3 groups and the bond strength values were compared among the groups, it does not seem that data dispersion compromises the integrity of the results.

### Conclusion

Based on the results, both methods recommended for decontamination of saliva-contaminated uncured bonding agent provided adequately high bond strength comparable to that of uncontaminated surfaces. However, it should be noted that these results were obtained from one in vitro test and further tests are required to draw a definite conclusion.

### References

1. Hormati AA, Fuller JL, Denehy GE. Effect of contamination and mechanical disturbance on the quality of acid etched enamel. *J Am Dent Assoc*. 1980 Jan; 100(1):34-8.
2. Fritz UB, Finger WJ, Stean H. Salivary contamination during bonding procedures with a one-bottle adhesive system. *Quintessence Int*. 1998 Sept; 29(9):567-72.
3. Abdalla AI, Davidson CL. Comparison of the marginal integrity of in vivo and in vitro class II composite restorations. *J Dent*. 1993 Jun;21(3): 158-162.
4. Gilbert GH, Litaker MS, Pihlstrom DJ, Amundson CW, Gordan VV. Rubber dam use during routine operative dentistry procedures: Findings from the dental PBRN. *Oper Dent*. 2010 Sept-Oct; 35(5):491-9.
5. Cacciafesta V, Sfondrini MF, De Angelis M, Scribante A, Klersy C. Effect of water and saliva contamination on shear bond strength of brackets bonded with conventional, hydrophilic, and self-etching primers. *Am J Orthod Dentofacial Orthop*. 2003 Jun;123(6):633-40.
6. Sheikh H, Heymann HJ, Swift E, Ziemiecki T, Ritter A. Effect of saliva contamination and cleansing solutions on the bond strengths of self-etch adhesives to dentin. *J Esthet and Restor Dent*. 2010 Dec; 22(6):402-410.
7. Powers JM, Finger WJ, Xie J. Bonding of composite resin to contaminated human enamel and dentin. *J Prosthodont*. 1995 Mar; 4(1):28-32.
8. Barghi N, Knight GT, Berry TG. Comparing two methods of moisture control in bonding to enamel: A clinical study. *Oper Dent*. 1991 Jul-Aug; 16(4): 130-135.
9. Johnson M, Burgess JO, Hermes CB, Buikema DJ. Saliva contamination of dentin bonding agents. *Oper Dent*. 1994 Nov-Dec;19(6): 205-210.
10. Hitmi L, Attal JP, Degrange M. Influence of the time-point of salivary contamination on dental shear bond strength of 3 dentin adhesive systems. *J Adhes Dent*. 1999 Fall; 1(3):219-232.
11. Koppolu M, Gogala D, Mathew V, Thangala V, Deepthi M, Sasidhar N. Effect of saliva and blood contamination on the bond strength of self-etching adhesive system- An in vitro study. *J Conserv Dent*. 2012 Jul; 15(3):270-273.
12. Jiang Q, Pan H, Liang B, Fu B, Hannig M. Effect of saliva contamination and decontamination on bovine enamel bond strength of four self-etching adhesives. *Oper Dent*. 2010 March-Apr; 35(2):194-202.
13. Darabi F, Tavangar M, Davaloo R. Effect of Different Decontamination Procedures on a Saliva-Contaminated Uncured Bonding System (Single Bond). *Dent Res J (Isfahan)*. 2012 Jul;9 (4):399-403.
14. Ghavam M, Khalaf Pour Sh. Effect of different saliva decontamination procedures on Bond strength to dentin in single bond system. *J Tehran Univ of Med Sci*. 2004 Jan; 1(3):5-10
15. Park J, Lee KC. The influence of salivary contamination on shear bond strength of dentin adhesive systems. *Oper Dent*. 2004 Jul-Aug;29 (4):437-442.