

In vitro evaluation of influence of salivary contamination on the dentin bond strength of one-bottle adhesive systems

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Abstract

Aim: To evaluate the effect of salivary contamination on the bond strength of one-bottle adhesive systems — (the V generation) at various stages during the bonding procedure and to investigate the effect of the contaminant removing treatments on the recovery of bond strengths. **Materials and Methods:** In this study the V generation one-bottle system — (Adper Single Bond) was tested. Fifty caries-free human molars with flat dentin surfaces were randomly divided into five groups of ten teeth each: Group I had 15 second etching with 35% Ortho Phosphoric acid, 15 second rinse and blot dried (Uncontaminated); Group II contaminated and blot dried; Group III contaminated and completely dried; Group IV contaminated, washed, blot dried; Group V contaminated, re-etched washed, and blot dried. The bonding agent was applied and resin composite (Z-100 3M ESPE) was bonded to the treated surfaces using the Teflon mold. The specimens in each group were then subjected to shear bond strength testing in an Instron Universal testing machine at a crosshead speed of 1 mm / minute and the data were subjected to one way ANOVA for comparison among the groups ($P < 0.05$). **Results:** There was a significant difference between the group that was dried with strong oil-free air after contamination (Group III) and the other groups. When the etched surface was contaminated by saliva, there was no statistical difference between the just blot dry, wash, or the re-etching groups (Groups II, IV, V) if the dentin surface was kept wet before priming. When the etched dentin surface was dried (Group III) the shear bond strength decreased considerably. **Conclusion:** The bond strengths to the tooth structure of the recent dentin bonding agents are less sensitive to common forms of contamination than assumed. Re-etching without additional mechanical preparation is sufficient to provide or achieve the expected bond strength.

Keywords: Artificial saliva, composite resin, dentin bond strength, salivary contamination

Introduction

The search for improved adhesive restorative materials has been the object of considerable research in recent years. The concept and practice of esthetic dentistry is now common to most clinicians around the world. Retention of restorative materials to the surfaces of tooth structure by means of adhesion is carried out routinely. Adhesion to dentin has been the subject of debate due to its heterogeneous nature, with much higher organic and water content than enamel.^[1] The chemical composition of the adhesive agents and the condition of the tooth

structure affect their bond strength.^[2] There are three individuals who made the most significant contributions in this aspect. First, Michael Buonocore, who demonstrated the concept of bonding acrylic resin to the enamel surface;^[3] Second, Rafael Bowen, who developed composite resin as an esthetic restorative material;^[4] and third, the investigator who continues to contribute to the field of esthetic dentistry, Nobuo Nakabayashi, whose efforts have led to the technique of bonding resin composites to the surface of the dentin.^[5] Since its introduction the acid-etch technique has become a universally accepted method to bond composite resin restorative materials to enamel. The search for an equally effective agent that bonds resin to dentin has proven to be more elusive, as dentin is biologically active and is complex in composition and morphological in structure. The general composition of human dentin in volume percent can be expressed as: 45% inorganic, 33% organic, and the remaining 22%, chiefly water.^[6] Over the years, many systems have evolved using a variety of enchants, conditioners, primers, and adhesive resins that either alter or remove the smear layer and create a mechanical bonding to dentin. Clinically, there are many factors that affect the adhesion and retention of restorative materials. Moisture, such as gingival fluid, blood, hand piece oil (Xie, Powers, Mc Guckin, 1993)^[7] and in particular, saliva, can affect the quality of the bond, leading to microleakage at the interface, thus, leading to loss of restoration, recurrent caries, postoperative sensitivity, and discoloration.

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However, most of the carious lesions requiring dentin bonding are found in areas that are difficult to isolate, especially when it is near or at the gingival margin where salivary contamination is more likely to occur (Mojon and others 1996).^[8] Even though contemporary dentin adhesive systems are easier to use and less technique sensitive, salivary contamination may occur, resulting in reduced bond strength and a marginal seal. Microscopic examination of such a contaminated surface shows the formation of an organic pellicle that cannot be removed by rinsing with water, but can be reconditioned by an additional 10 seconds of acid conditioning.^[9]

The aim of this study is to:

- Evaluate the effect of salivary contamination on the bond strength of one-bottle adhesive systems — (the V generation) — at various stages during the bonding procedure
- To investigate the effect of the contaminant-removing treatments on recovery of the bond strengths

Materials and Methods

In this study, the V generation one-bottle system — the Adper Single Bond was tested (3M ESPE). Fifty caries-free, sound human molars, extracted for periodontal reasons were obtained from the Department of Oral and Maxillofacial Surgery, of the Government Dental College and Hospital, Hyderabad, and were stored in normal saline at 4°C, until further use. The teeth were then cleaned of soft tissue debris and embedded in square-shaped Aluminum molds, with self-cure acrylic resin, till the cervical region.

The occlusal surfaces of the teeth were reduced on a water-cooled model trimming wheel, to create flat dentin surfaces. The surfaces were then wet ground with 600 and then 800 grit silicon carbide abrasive papers [Figure 1] and stored in normal saline till further use.

Preparation of Artificial Saliva

Artificial saliva required for this study was obtained from the Department of Biochemistry, Osmania General Hospital, Hyderabad. The composition of artificial saliva is: [Figure 2].

Sorbitol	—	15%
NaOH	—	0.05 M
Na ₂ HPO ₄	—	0.2 M
Tricalcium phosphate	—	0.053%
NaCl	—	0.42 g
Magnesium lactate	—	0.026 g
HCl	—	0.01 N
Distilled water	—	500 ml

Materials

- Thirty-five percent Orthophosphoric acid — 3 M ESPE
- Adper Single Bond-V generation adhesive — 3 M ESPE
- Composite Resin — Z100 3 M ESPE [Figure 3]

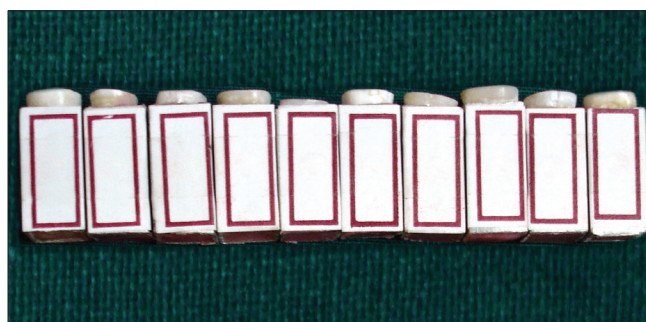


Figure 1: Teeth mounted in square-shaped aluminum molds with occlusal surfaces made flat



Figure 2: Artificial saliva



Figure 3: Materials used in this study

Sample preparation

The 50 samples with flat dentin surfaces were randomly divided into five groups of ten teeth each, which received the following treatment:-

Group I (Control): Fifteen seconds of etching with 35% Orthophosphoric acid, 15 seconds of rinsing, followed by blot drying, and bonding agent application

Group II : Etching, rinsing, artificial saliva applied for

- 20 seconds with disposable brush, blot drying, and bonding agent application
- Group III : Etching, rinsing, artificial saliva application for 20 seconds, completely dried, bonding agent application, and light curing for 20 seconds
- Group IV : Etching, rinsing, artificial saliva application for 20 seconds, followed by washing, blot drying, bonding agent application, and light curing for 20 seconds (10 seconds for each coat)
- Group V : Etching for 15 seconds, rinsing for 15 seconds, application of artificial saliva for 20 seconds, re-etching for 10 seconds, washing and blot drying, and then application of bonding agent

The bonding agent was applied in two layers and each layer was light cured for 10 seconds. On the surface of all the 50 samples, Teflon mold [Figure 4] of 3 mm internal diameter and 2 mm height were used, and a resin composite (Z-100 3M ESPE) was packed and light cured for 40 seconds [Figure 5]. The Teflon mold was removed after polymerization and the prepared samples, with composite cylinders attached [Figure 6], were placed in 37°C distilled water for 24 hours. The specimens in each group were then subjected to shear bond strength testing on a Universal Instron testing machine, at a crosshead speed of 1 mm / minute. The data were subjected to one-way ANOVA for comparisons among the groups ($P < 0.05$).

Results

The results for all ten samples from Group I – Group V are as shown in Table 1. The mean shear bond strength (SBS) of the samples for each group is given in Table 2 and Chart 1. There was a significant difference between the group that was dried with strong oil-free air after contamination (Group III) and other groups. When the etched surface was contaminated by saliva, there was no statistical difference between just blot dry, wash, or the re-etching groups (Groups II, IV, V) if the dentin surface was kept wet before priming. When the etched dentin surface was dried (Group III) the shear bond strength decreased considerably (9.2 MPa).

Discussion

Contamination of the field of operation by saliva or blood is a frequent problem in adhesive dentistry when isolation by a rubber dam is not possible or when cavity margins extend below the gingival tissues.^[10,11]

Dentin bonding systems are sensitive to contamination by excess water, artificial saliva, and plasma.^[12] This has been attributed to the absorption of macromolecules from contaminating materials into the dentinal tubules.^[13] Therefore,

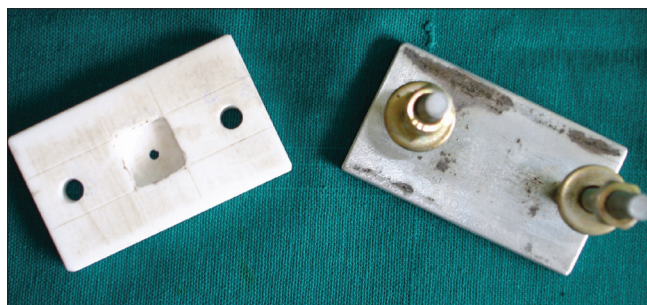


Figure 4: Teflon mold used for bonding composite cylinders

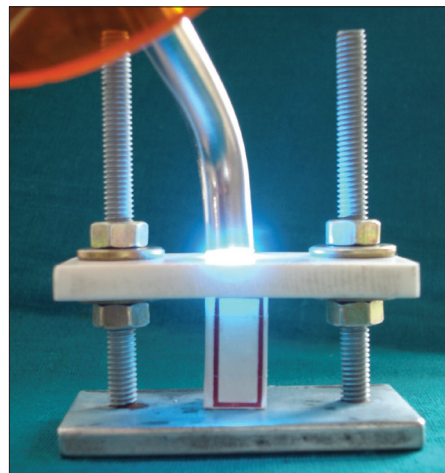


Figure 5: Sample in place in the Teflon mold for curing of composite cylinders

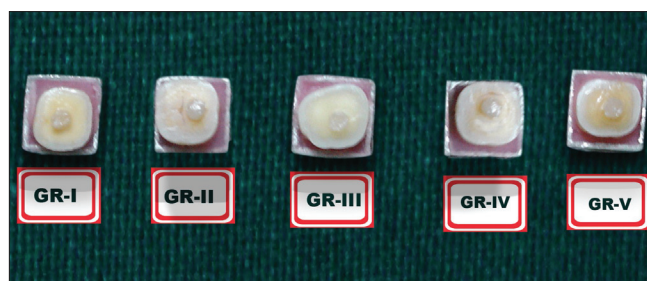


Figure 6: Representative samples of Groups I to V with composite cylinders bonded

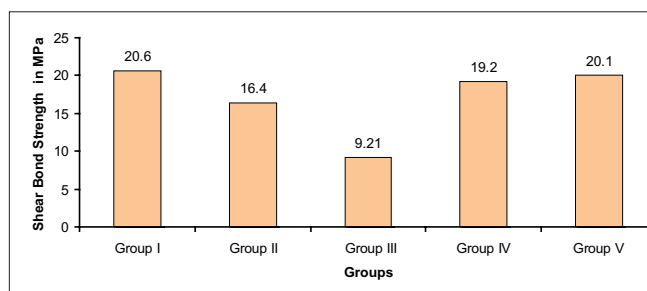


Chart 1: Shear bond strength Group I to V

adhesive systems capable of tolerating contamination are highly desirable. Although a moist collagen web may enhance primer infiltration,^[14] the presence of water can weaken the

Table 1: Shear bond strength of all 10 samples of Groups I – V (in MPa)

Group – I	Group – II	Group – III	Group – IV	Group – V
21.3	16.8	9.6	19.6	20.9
20.1	16.2	9.4	19.2	20.7
20.7	15.4	8.9	18.9	19.6
21.1	15.8	8.6	17.7	19.9
19.8	14.9	9.1	18.2	20.3
20.1	16.9	10.2	20.6	21.7
20.2	17.3	8.4	19.4	22.1
18.6	17.6	8.7	19.3	18.7
22.7	15.2	9.1	18.6	21.1
21.5	17.7	10.1	20.4	18.2

Table 2: Mean shear bond strength of Groups I – V

Groups	n (sample size)	Shear bond strength (mean) in MPa
Group I	10	20.6
Group II	10	16.4
Group III	10	9.21
Group IV	10	19.2
Group V	10	20.1

bond strength if not remove it, before the resin is cured. Thus, the use of adhesive systems on moist dentin is made possible by the incorporation of organic solvents acetone or ethanol in the primers or adhesives.

The present study evaluated the influence of salivary contamination on the shear bond strength of one-bottle adhesive systems to dentin. A comparison of Shear Bond Strengths (SBS) among the various groups was conducted.

When the contaminated surface is blot-dried, (Group II) the decrease in SBS is not significant (16.4 MPa). The hydrophilic nature of one-bottle adhesives may allow them to function to some degree in the presence of saliva contamination, perhaps displacing or diffusing through it, to infiltrate and polymerize within the exposed collagen bundles of the demineralized superficial dentin. This creates the transitional resin-reinforced 'Hybrid zone'^[15] through micromechanical retention. Thus, for one-bottle systems, blot drying the surface is sufficient to achieve optimal bond strength after salivary contamination.

The salivary contaminant was removed by washing followed by 10 seconds of re-etching using the original acid etching agent (35% H₃PO₄), as it was not detrimental to the bond strength.^[14] The results revealed no significant difference between Group II and Group V; control Group I.^[12] reported the restoration of bond strength to the re-etched and re-surfaced dentin. In contrast, the present study^[7] found that salivary contamination of the dentin surface produced a

significant decrease in Shear Bond Strength, which may be explained by the application of excessive amounts of water and artificial saliva (4 µL) that possibly diluted the primer, producing a weak hybrid layer.

Conclusions

For effective bonding the primer should infiltrate the demineralized collagen web. The present study showed that salivary contamination had no significant effect on the Shear Bond Strength of the one-bottle system when it was blot dried, washed or retched with H₃PO₄. When the contaminated surface was dried completely, there was a significant decrease in the bond strength. The bond strengths to the tooth structure of the recent dentin bonding agents were less sensitive to the common forms of contamination than assumed. Re-etching without additional mechanical preparation was sufficient to provide or achieve the expected bond strength. Thus, adhesive restorations should have sufficient bond strength to prevent microleakage around the restoration margins and to reinforce the tooth structure against forces that cause fractures. Reliable bonding systems have revolutionized the practice of adhesive dentistry, although improvements in bonding techniques and systems have to be continued.

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