ORIGINAL ARTICLE

Effect of blood and saliva contamination on bond strength of brackets bonded with a protective liquid polish and a light-cured adhesive

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Introduction: The application of a polymer coating to the labial enamel tooth surface before bonding can help keep white spot lesions from forming. Previous studies evaluating the effects of blood and saliva contamination on the bond strengths of light-cured composites showed significant reductions in bond strength values. The purpose of this study was to investigate whether the bond strength of a light-cured system (Transbond XT, 3M Unitek, Puchheim, Germany) used with a liquid polish (BisCover, Bisco, Schaumburg, Ill) is affected by contamination with blood or saliva. **Methods:** One hundred twenty permanent human premolars were randomly divided into 6 groups of 20. Various enamel surface conditions were studied: dry, blood contaminated, and saliva contaminated. A light-cured bonding system (Transbond XT) was used in all groups. The teeth in group 1 were bonded with Transbond XT. In the second group, BisCover polymeric resin polish was applied on the etched tooth surfaces before the brackets were bonded with Transbond XT resin. Comparison of the first and second groups showed no statistically significant difference. Groups 3 through 6 were bonded without Transbond XT. For groups 3 and 5, a layer of blood or saliva, respectively, was applied to the etched enamel followed by BisCover. In groups 4 and 6, blood or saliva, respectively, was applied on the light-cured BisCover. Shear forces were applied to the samples with a universal testing machine, and bond strengths were measured in megapascals. **Results:** The protective liquid polish (BisCover) layer did not affect bond strength. **Conclusions:** Blood contamination on acid-etched surfaces affects bond strength more than saliva contamination. When a protective liquid polish (BisCover) is applied to the tooth surface, the effect of contamination by blood or saliva is prevented. (Am J Orthod Dentofacial Orthop 2007;131:391-4)

A frequently encountered problem in orthodontics with fixed appliances is localized decalcification of the enamel around the bonded bracket, referred to as white spot lesions, that can occur within a few weeks of appliance placement.[1-7] The prevalence of white spot lesions in patients who seek orthodontic treatment is about 50% to 96%.[4,5,7] One solution for this problem is a polymer coating applied to the labial enamel surfaces of teeth under the brackets.[8] A clinical trial also showed that the application of light-cured resin sealants to the labial enamel surface reduced demineralization by 13%.[9] Another study found that applying a polymeric coating on etched enamel had a greater effect than both the control and the chlorhexidine varnish groups.[10] A study by Joseph and Rossouw[11] investigated the bond strength of brackets bonded to teeth with orthodontic composite resin (Concise) and various fissure sealants. The study showed that the application of fissure sealants did not change bond values, and, in addition, the bond failure site was located more often at the resin/enamel interface than in teeth without sealant, thus leaving less cleaning of tooth surfaces after debonding. These studies all agreed on the need for further research to develop a material that would provide greater enamel protection without compromising the bond strength of the brackets.

A new material, BisCover (Bisco, Schaumburg, Ill), developed to totally eliminate the formation of the oxygen-inhibition layer by chemical means, was used in a highly reactive, multifunctional, acrylate-based, light-cured surface sealant and glaze. Eliminating the

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Submitted, February 2005; revised and accepted, April 2005.
0889-5406/$32.00

doi:10.1016/j.ajodo.2005.04.049

Table I. Bonding procedures

Group 1	38% phosphoric acid	Rinsing/drying	Dry	Primer—Transbond XT			Adhesive—Transbond	Light-cure
Group 2	38% phosphoric acid	Rinsing/drying	Dry	BisCover	Light-cure		Adhesive—Transbond	Light-cure
Group 3	38% phosphoric acid	Rinsing/drying	Blood	BisCover	Light-cure		Adhesive—Transbond	Light-cure
Group 4	38% phosphoric acid	Rinsing/drying	Dry	BisCover	Light-cure	Blood	Adhesive—Transbond	Light-cure
Group 5	38% phosphoric acid	Rinsing/drying	Saliva	BisCover	Light-cure		Adhesive—Transbond	Light-cure
Group 6	38% phosphoric acid	Rinsing/drying	Dry	BisCover	Light-cure	Saliva	Adhesive—Transbond	Light-cure

oxygen-inhibition layer and converting it to a glaze layer removes the need for further polishing with this new material. A recent study showed that the liquid polish BisCover did not change the bond strength values for a light-cured or a no-mix system for orthodontic bracket bonding and also that no additional bonding resin was required when BisCover was used.[12]

Etching tooth surfaces with phosphoric acid to bond acrylic resin to tooth enamel was introduced in 1955 by Buonocore.[13] Acid etching differentially dissolves enamel crystals in the prism structure; this results in a roughened surface ready for micromechanical retention. Traditional composite resin bonding materials require completely dry surfaces to obtain clinically acceptable bond strengths. However, various clinical conditions do not permit ideal isolation of the bonding site, especially when bonding attachments to hard-to-reach places near the gingival area, around second molars, or when exposing and attaching buttons to partially erupted or impacted ectopic teeth.[14-17] When etched enamel becomes wet, most of the porosities become plugged, and resin penetration is impaired. This results in resin tags of insufficient numbers and lengths. Even momentary saliva or blood contamination might adversely affect the bond, because saliva and blood deposit an organic adhesive coating that resists washing in the first few seconds of exposure.[18,19] Previous studies that evaluated the effect of blood contamination on the bond strengths of light-cured composites showed significant reductions in bond strength values.[15,20] The purpose of this study was to investigate whether the bond strength of a light-cured system (Transbond XT, 3M Unitek, Puchheim, Germany), when used with a liquid polish (BisCover), is affected by contamination with blood or saliva.

MATERIAL AND METHODS

One hundred twenty recently extracted human premolars were collected, cleaned of soft tissue, and stored in a solution of 70% (weight/volume) ethyl alcohol. The criteria for tooth selection included intact buccal enamel, no pretreatment chemical agents (eg, hydrogen peroxide), no cracks caused by the extraction forceps, and no caries. The teeth were polished with pumice and rubber prophylactic cups for 10 seconds. The teeth were randomly assigned to 6 groups. Each group contained 20 specimens. One hundred twenty standard stainless steel premolar brackets with 0.018-in slots (DynaLock, 3M Unitek, Monrovia, Calif) were bonded by 1 operator (K.S.). Three enamel surface conditions were studied: dry, blood contaminated, and saliva contaminated. A light-cure bonding system (Transbond XT) was used in all groups. The bonding procedure for each group is described in Table I. The teeth in all groups were conditioned with 38% phosphoric acid (Etch-Rite, Pulpdent, Watertown, Mass) for 30 seconds followed by thorough washing and drying. The teeth in group 1 were bonded with Transbond XT as recommended by the manufacturer and light-cured with a halogen light-curing unit (Optilux, Kerr, Orange, Calif) for 20 seconds on the mesial sides and 20 seconds on the distal sides (total cure time, 40 seconds). In the second group, BisCover polymeric liquid polish was applied on the etched tooth surfaces, and the teeth were light-cured with a halogen light-curing unit (Optilux) with a minimum output of 500 mW per square centimeter for 15 seconds per tooth at close range (0-2 mm), as recommended by the manufacturer, before the bracket was bonded with Transbond XT adhesive. Comparison of first and second groups showed no statistically significant difference; therefore, the rest of the sample teeth were bonded without Transbond XT. For groups 3 and 5, a layer of blood or saliva, respectively, was applied to the etched enamel with a brush. Then BisCover was applied. In groups 4 and 6, blood or saliva, respectively, was applied on the light-cured BisCover.

After bonding, all samples were stored in distilled water at 37°C for 72 hours. Each tooth was oriented with a guiding device, so that its labial surface was parallel to the shear force during the test (Fig 1). Then a specially prepared cylindrical metal ring was placed around each tooth. The ring was filled with self-curing, fast-setting acrylic until it was 3 mm below the bracket. A 0.016 × 0.022-in stainless steel wire was placed under the wings of the bracket with ends of the wire clamped to the self-centering upper jaw of the universal testing machine (Zwick, GmbH & Co, Ulm, Germany).

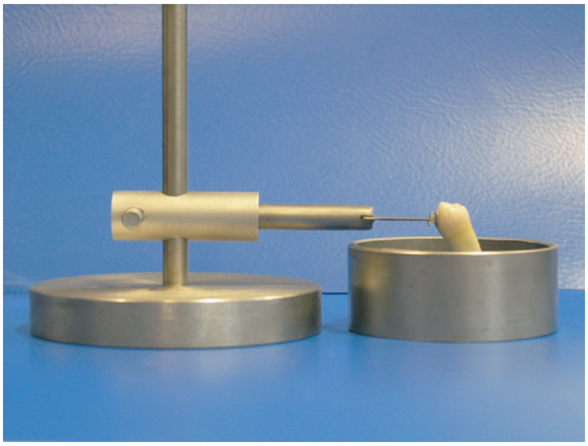

Fig 1. Specimen oriented with guiding device into ring.

Table II. Shear bond strength (MPa) and unpaired t test results for groups 1 and 2.

	Mean	*SD*	*Maximum*	*Minimum*
Group 1	13.03	2.40	16.99	9.55
Group 2	13.33	2.51	18.38	10.18
P value	.696			
Significance	NS			

NS, Not significant.

Each specimen was stressed in a gingivo-occlusal direction to failure with a speed of 3 mm per minute. A computer electronically connected with the testing machine recorded the results of each test. Bond strengths were measured in megapascals (MPa).

Statistical analysis

Statistical calculations were made with Prisma software (version 3.0, GraphPad, San Diego, Calif) for Windows. An unpaired *t* test was used to compare groups 1 and 2. In addition to standard descriptive statistical calculations (mean and standard deviation), 1-way analysis of variance (ANOVA) was carried out to compare groups 2 through 6 (Table III). In the evaluation of the groups, the Tukey multiple comparison test was used (Table IV). The results were evaluated with a 95% confidence interval. The statistical significance level was established at $P < .05$.

RESULTS

The shear bond strength values for groups 1 and 2 had no statistically significant differences (Table II). Therefore, in the following intergroup statistics, the first group was not evaluated. The means, standard deviations, and highest-lowest values for shear bond strengths in groups 2 to 6 are given in Table III. When the results were statistically evaluated, shear bond strengths of the groups contaminated before BisCover application showed significantly smaller shear bond values (Table III). On the other hand, teeth contaminated after BisCover application had values similar to those of group 2, with no contamination. In the groups contaminated before BisCover application, the blood-contaminated group 3 had lower values than the saliva-contaminated group 5. The blood-contaminated group 4 and the saliva-contaminated group 6, contaminated after BisCover application, did not differ significantly (Table IV).

Table III. Shear bond strength (MPa) and results of 1-way ANOVA for groups 2-6.

	Mean	*SD*	*Maximum*	*Minimum*
Group 2	13.33	2.51	18.38	10.18
Group 3	4.95	2.35	10.14	1.45
Group 4	12.34	2.05	15.48	9.14
Group 5	9.24	1.93	12.44	5.25
Group 6	13.28	2.61	17.70	8.31
P value	.0001			
Significance	*			

*$P < 0.01$.

DISCUSSION

The effect of 2 contaminants, blood and saliva, were evaluated before and after the application of the protective polish BisCover.

A protective layer on tooth surfaces under brackets was previously recommended.[8-11] The bond strength values for a similar protective layer were investigated previously.[11] Shear bond strength values for BisCover were also documented[12]; however, the effect of blood and saliva contamination with BisCover has not been studied until now.

The first step of the experiment was to test whether additional bonding was needed when BisCover was used. Additional bonding did not change bond strengths. The results of both groups were comparable with the results of other studies with Transbond as the bonding material.[21,22]

The second step involved the test of blood and saliva contamination before and after BisCover application. The results showed that contamination on acid-etched enamel surfaces damages bond strength the most. This result agrees with previous findings that, when the acid-etched surface becomes wet, most porosities become plugged, and resin penetration is impaired. This results in resin tags of insufficient numbers and lengths. Even momentary saliva or blood contam-

Table IV. Results of Tukey multiple comparison test

	Group 2	*Group 3*	*Group 4*	*Group 5*	*Group 6*
Group 2		<0.001		<0.001	
Group 3			<0.001	<0.001	<0.001
Group 4				<0.001	
Group 5					<0.001

ination adversely affects bond strength, because saliva and blood deposit an organic adhesive coating that resists washing in the first few seconds of exposure.[18,19] This study also showed that blood contamination on acid-etched surfaces (group 3) reduces bond strength more than saliva contamination (group 5).

Previous studies on saliva and blood contamination found that the time at which the contamination occurred during bonding procedures had no significant influence on bond strength values.[20,23] However, in this study, greater bond strength values were found in groups 4 and 6, in which BisCover helped to limit the damaging effects of contamination. The reason for successful bonding in these groups probably is the light-curing of the bonding material, resulting in resin tags of sufficient numbers and lengths, before contamination with blood or saliva.

CONCLUSIONS

A protective liquid polish (BisCover) layer can be applied to tooth surfaces before bracket bonding without affecting bond strength. This study also showed that blood contamination on acid-etched surface reduces bond strength to a greater extent than saliva contamination. When BisCover was applied to tooth surfaces, the negative effect of blood or saliva contamination on bond strength was prevented.

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