Bond strength to primary tooth dentin following disinfection with a chlorhexidine solution: an in vitro study

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Abstract

Purpose: The aim of this study was to determine the effect on shear bond strength of chlorhexidine used as a cavity disinfectant on primary tooth dentin.

Methods: Thirty specimens were randomly divided into 3 groups (N=10) and treated as follows: (1) in Group I, the dentin was acid etched with a 37% phosphoric acid for 15 seconds, washed and dried; (2) in Group II, a 2% commercial chlorhexidine solution (Cav Clean) was applied for 40 seconds, washed and dried following acid etching for 15 seconds; and (3) in Group III, dentin was treated with a 37% phosphoric acid gel containing 2% digluconate of chlorhexidine (Cond AC) for 15 seconds. In all specimens, the adhesive Single Bond (3M) was applied, and composite cylinders (Filtek Z 250) were built. The specimens were sheared with a universal testing machine (Instron) running at a crosshead speed of 0.5 mm/min, and the results calculated in MPa. The specimens were also observed to record the failure mode.

Results: ANOVA analysis revealed that the shear bond strength of Group II (17.99+1.15 MPa) was significantly lower than Group I (19.88+1.02 MPa) and Group III (19.57+1.02 MPa). After debonding, 63% of the specimens presented cohesive failure of the material, 24% adhesive failure and 10% cohesive failure of dentin.

Conclusions: The commercial cavity disinfectant containing 2% chlorhexidine had an adverse effect on Single Bond and produced significantly lower shear bond strength than the etch gel with chlorhexidine and the acid etch alone. (*Pediatr Dent*. 2003;25:49-52)

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Enamel adhesion by means of acid etching has become an accepted technique in restorative dentistry. Adhesion to dentin, however, is still under investigation in order to find adhesive systems that are capable of interacting efficiently with this substrate.

The new generation of dentin adhesives has increased the bond strength between composite resins and tooth structures. This has allowed a decrease in marginal leakage and, therefore, the penetration of oral fluids at the tooth/restoration interface. A decreased leakage avoids bacterial contamination, which decreases secondary caries, color alterations of the margins, postoperative sensitivity, and pulp alterations.[1]

Secondary decay can also be the result of the action of bacteria left under restorations. The long-term fate of residual bacteria is as yet unknown. Results of further investigations[3-5] have shown the presence of bacteria in dentin after the removal of infected dentin even after the removal of a dye-stainable dentin.

The use of disinfectant solutions is an alternative procedure to reduce or eliminate bacteria from cavity preparations. Some antibacterial solutions have been studied: chlorhexidine, sodium hypochlorite, and fluoride solutions.[5,6]

Studies have reported that adhesion could be impaired by a series of previous dentin treatments. Results of in vitro studies in permanent teeth, found in the literature, are controversial regarding whether or not the use of disinfectants previously affects adhesion.[5-7] Only 1 study regarding primary teeth was found.[8]

The purpose of this in vitro study was to determine the effect on shear bond strength of chlorhexidine used as a cavity disinfectant on primary tooth dentin.

Methods

Fifteen recently extracted second primary molars were collected and randomly divided into 3 groups. The teeth were stored in a 0.1% thymol solution. The criteria for tooth selection included: (1) intact crown enamel; and (2) no caries or cracks. A X20 magnifying glass was used for these determinations. The teeth were cleansed and then pumiced with a rubber prophylaxis cup and pumice for 30 seconds. Teeth were sectioned in a mesiodistal direction and each hemisection was embedded in acrylic resin and ground with a polishing machine to create a flat superficial dentinal surface. A no. 600 grit sand paper was used to polish the dentinal surface and create a smear layer.

The 30 specimens were randomly divided into 3 groups with 10 specimens per each group and treated as follows:

1. Group I—the dentin was etched with a 37% phosphoric acid gel for 15 seconds, then washed off and dried using absorbent paper.
2. Group II—a 2% chlorhexidine digluconate cavity cleanser (Cav-Clean, Herpo, Brazil) was applied for 40 seconds, according to the manufacturer's instructions, then washed off and dried. Next, the dentin surface was acid etched with a 37% phosphoric acid gel for 15 seconds, then washed and dried with absorbent paper.
3. Group III—dentin was treated with a 37% phosphoric acid gel containing 2% chlorhexidine digluconate (Cond AC, FGM, Brazil) for 15 seconds, according the manufacturer's instructions.

After this dentin treatment, the 1-step dentin bonding system, Single Bond (3M Co, United States), was applied on the dentin surface of all specimens and light cured for 20 seconds.

Next, the composite resin cylinders were built using a Teflon matrix (Ultra dent Products, United States), in which the bonding area had 3 mm in diameter and the superior area 6 mm. The composite resin (Filtek Z 250, 3M Co, United States) was applied in 3 increments, each one light-cured for 40 seconds with a lamp (Ultralux, Dabi Atlante, Brazil) with an energy higher than 400 µw/mm as measured by a curing radiometer (Demetron, United States). The test specimens were then stored in 100% humidity for 24 hours at 37°C. The shear test was performed using a Universal testing machine (Instron, model 4444, United States) at a cross speed of 0.5 mm/min.

The results were obtained at the moment of the specimen fracture and calculated in MPa, according to the surface area of the adhesion. Data were submitted to statistical analysis using the one-way analysis of variance (ANOVA) and Sheffeé tests. Each fractured specimen was examined under a stereomicroscope (Dimex, MZS-200, Mexico), with X40 magnificent to record the failure mode. When there was remnant-fractured material at the dentin/resin interface, the fracture was classified as cohesive to the material. When there was dentin fracture, it was classified as cohesive to dentin and an adhesive fracture when there was no resin left over the dentin.

Results

The results are displayed in Table 1. The ANOVA indicated that there were statistically significant differences (P=.0012) in shear bond strengths between the 3 groups tested. Scheffeé analysis indicated that Groups I and III were equivalent and presented a significantly higher shear bond strength (P<.05) than Group II. Table 2 shows the results of the types of fractures observed. Evaluation under stereo-microscope showed that, after debonding, 63% of the specimens presented cohesive failure of the material, 24% adhesive failure, and 10% cohesive failure of dentin.

Discussion

Residual microrganisms under restorations can cause recurrent caries and limit the dentin sealing ability of bonding agents. Therefore, cavity sterilization has become an important sequence in restorative procedures.[9] Phosphoric acid etchant materials demonstrate antimicrobial activity against some of the bacteria involved in caries.[10] However, some studies have shown that, even after using the newest dentin bonding agents, a certain microleakage is apparent that allows the entrance of oral fluids that can be used by residual bacteria as a nutritional requirement and bacterial entry.[5,10] This mechanism is responsible for secondary caries. It would be necessary or advisable to place an additional disinfectant within etching materials to treat dentin surfaces with antimicrobials prior to the placing of restoratives.

Table 1. Results of the Statistical Tests Comparing the Shear Bond Strengths in Mega Pascals for the 3 Groups Tested

Groups tested	Shear bond strength (Mpa)	Standard deviation (SD)
Group I etch+da+cr	19.88[A*]	1.04
Group II CHXD+etch+ad+cr	17.99[B]	1.15
Group III GHXD+ad+cr	19.57[A]	1.02
	F value=9.1306	

*Means with the same letter are equivalent.
Etch=acid etching; da=dentin adhesive; cr=composite resin; CHXD=chlorhexidine; GCHXD=acid gel with chlorhexidine.

Table 2. Frequency of Bond Fracture Type

Groups	Cohesive fracture of the material	%	Adhesive fracture	%	Cohesive fracture of dentin	%
I	6	60	3	30	1	10
II	5	50	3	30	2	20
III	8	80	2	20	0	0

Chlorhexidine is one of the most widely used broad-spectrum antibacterial or antiseptic agents in dentistry. It has proven to be very effective in the maintenance of plaque control and gingivitis in both short- and long-term in vivo studies without developing resistant organisms in the oral flora.[11,12] Chlorhexidine solutions have been also indicated to be placed after cavity preparation to disinfect dentin.

Meirs and Kresin,[5] in an in vitro study, found that the use of cavity disinfection after tooth preparation and before the application of a dentin bonding agent could help reduce the potential for residual caries. These investigators evaluated the effect of 2 dentin disinfectants—one chlorhexidine-based and the other an iodine/potassium cooper sulfate solution. They stated that cavity disinfectants used with composite resin restorations might be material specific regarding their interactions with various dentin bonding systems' ability to seal dentin. However, Tulunoglu et al,[8] in an in vivo study, found that chlorhexidine cavity disinfectant increased microleakage scores when used prior to the implementation of Syntac and Prime & Bond dentin adhesive systems. They stated that there might have been some negative interaction between the cavity disinfectants and dentin bonding agents.

The results of this in vitro study showed shear bond strength means of 19.88 MPa for Group I, 17.99 MPa for Group II, and 19.57 MPa for Group III—all higher values than 17.6 Mpa, which is the minimum value recommended for bond strength to dentin in primary and permanent teeth.[13-15] In the present study, the disinfectant was applied before the removal of the smear layer by the all-etch technique, in accordance with Meiers and Kresin.[5] However, the sequence for disinfectant application of Tununoglu et al,[8] was different than the sequence used by the authors of this study. Tulunoglu et al applied the disinfectant after the removal of the smear layer via the all-etch technique. This application is in accordance with the Perdigão et al, study.[16] Group II, in which chlorhexidine was applied before the removal of the smear layer using the all-etch technique, showed a lower shear bond strength than Group I, in which chlorhexidine was not used, and Group III, in which the disinfectant was present in the acid gel.

At the time of writing of this study, only 1 study[8] was found related to the effects of disinfectants on the shear bond strength of dentin adhesive systems to primary tooth dentin. It was an in vivo study in which the effect on microleakage of 2 disinfectants—one chlorhexidine-based and the other alcohol-based—was determined.

Those authors used the disinfectants prior to the application of dentin adhesives (Syntac and Prime & Bond) in Class V composite restorations and found that the use a 2% chlorhexidine solution had adverse effects and produced significantly higher microleakage when used under dentin bonding systems. They concluded that the use of cavity disinfectants with composite resin restorations appeared to be material specific regarding the interactions with various dentin bonding systems and the ability to seal dentin.

However, the study of Meirs and Kresin[5] in permanent teeth evaluated the effect of 2 dentin disinfectants on the dentin sealing ability of 2 dentin bonding systems (Tenure and Syntac) and found that the use of cavity disinfecting after tooth preparation and before the application of dentin bonding agent could help to reduce the potential for residual caries. A significantly lower shear bond strength showed by Group II may be due to the fact that remnants of chlorhexidine could interact with calcium and phosphate present in dentin and, therefore, inhibit the bonding ability of the bonding agent. This probably did not occur in group III, because chlorhexidine was not applied alone—it was part of the etch gel, and the time it was left over dentin probably could influence the results. In Group II, the disinfectant solution was applied for 40 seconds and in group III applied for 15 seconds, according to the manufacturer's instructions.

Although there was a statistically significant difference between Groups I and III and Group II, the shear bond strength means were higher than 17.6 MPa, which is the minimum value recommended for bond strength to dentin in primary and permanent teeth. Therefore, more in vitro and in vivo studies should be conducted to evaluate the interaction between bonding agents and cavity disinfectants if the difference found between the groups is clinically significant.

Cohesive fracture of the material for all groups occurred after the debonding tests were the most prevalent type of fractures (Table 2). According to el-Kalla and García-Godoy,[15] products with a lesser amount of fracture within the adhesive resin attain a higher bond strength. These products are likely to be clinically acceptable in the long term. A cohesive fracture could be considered as a superior property of the adhesive system because it shows there is no further need for higher bond strength.

Conclusions

1. A commercial cavity disinfectant (CavClean) containing 2% chlorhexidine digluconate had an adverse effect on Single Bond adhesive and produced significantly lower shear bond strength when used under this bonding system.
2. The use of an etch gel containing 2% chlorhexidine digluconate (CondAc) did not affect adhesive bonding, showing a similar bond strength to the group that was acid etched only.

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Abstract of the Scientific Literature

Erythromycin-resistant Group A Streptococci in Schoolchildren in Pittsburgh

Group A streptococci is the most frequent cause of bacterial pharyngitis in children and adults. Although many antibiotics are effective for the treatment of streptococcal pharyngitis, penicillin V remains the drug of choice. Erythromycin is recommended for persons who are allergic to penicillin. Azithromycin is not recommended as first-line therapy for pharyngitis due to group A streptococci. However, many practitioners find the 5-day regimen of one dose of azithromycin per day attractive. Azithromycin and other macrolide antibiotics are also frequently prescribed for nonstreptococcal pharyngitis and other upper respiratory tract infections. The increased use of macrolide antibiotics is correlated with an increased rate of resistance to erythromycin among isolates of group A streptococci.

The authors detected the emergence of erythromycin resistance in pharyngeal isolates of group A streptococci among schoolchildren in Pittsburgh. Between October 1998 and May 2000, none of the group A streptococci studied were resistant to macrolide antibiotics. Between October 2000 and May 2001, however, no less than 48% of the isolates were resistant, and resistant isolates were also found at a high rate in the surrounding community.

Comments: It is recommended that macrolide antibiotics not be used for the routine treatment of pharyngitis due to group A streptococci until more epidemiologic information is available or unless susceptibility testing is first performed. **JM**

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Martin JM, Green M, Barbadora KA, Wald, ER. Erythromycin-resistant group A streptococci in school children in Pittsburgh. *N Engl J Med.* 2002;346:1200-1206.

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