Original Article

Effects of Chlorhexidine and Povidone-Iodine Mouth Rinses on the Bond Strength of an Orthodontic Composite

Abdullah Demir[a]; Siddik Malkoc[b]; Abdulkadir Sengun[c]; Alp Erdin Koyuturk[d]; Yagmur Sener[e]

Abstract: The purpose of this study was to determine whether the application of two antibacterial mouth rinses to etched and unetched enamel affects the shear bond strength (SBS) of an orthodontic composite resin. Eighty-five lower human incisors were divided into five groups, ie, group 1: control group, no mouth rinse was used; groups 2 and 3: mouth rinses were applied to the intact enamel surface before etching; groups 4 and 5: mouth rinses were applied to the etched enamel. A bonding agent and a composite resin were applied to the teeth surface. For shear bond testing, the specimens were mounted in a universal testing machine, and an apparatus attached to a compression load cell was applied to each specimen until failure occurred. The data were analyzed using analysis of variance and Tukey honestly significance tests. Fracture modes were analyzed by Mann-Whitney *U*-test. There was no statistically significant difference between the SBS values of group 1 (31.64 $\pm$ 3.62 MPa) and group 4—five experimental applications ($P \geq .05$). However, the SBS value of group 3 (36.56 $\pm$ 5.95 MPa) was significantly larger than those of group 4 (30.00 $\pm$ 4.97 MPa) and group 5 (30.26 $\pm$ 7.30 MPa). In addition, no significant differences were observed between group 1 and groups 2 (34.33 $\pm$ 7.26 MPa) and 3 (36.56 $\pm$ 5.95 MPa) ($P \geq .05$). Because the application of chlorhexidine and povidone-iodine before acid etching did not cause any decrease in bond strength, it is advisable for use under the orthodontic resin composite to obtain an antibacterial effect or to prevent the risk of bacteremia. (*Angle Orthod* 2005;75:392–396.)

Key Words: Chlorhexidine; Povidone-iodine; Shear bond strength

INTRODUCTION

Transient bacteremia after orthodontic procedures has been shown in clinical investigations. In a study on 10 patients, Degling[1] showed no bacteremia after the placement and removal of orthodontic bands. On the other hand, McLaughlin et al[2] reported around a 10% prevalence of bacteremia after banding procedures. Erverdi et al[3–5] found bacteremia prevalences of 7.5% and 6.6% after banding and debanding procedures, respectively. Antiseptic mouthwashes applied immediately before dental procedures may reduce the incidence and severity of bacteremia.[6–10]

Chlorhexidine has been used as an effective adjunct treatment for periodontal disease, both as a mouth rinse and as one of the ingredients in toothpaste.[11] Chlorhexidine mouthwash is commercially available in 0.12% and 0.2% concentrations. The mechanism of action of a chlorhexidine mouthwash seems to be an immediate and probably short-lived bactericidal effect, followed by a prolonged bacteriostatic action that is dependent on antiseptic absorbed by the pellicle coating tooth surface.

Considering the drawbacks of antibiotic use, the use of chlorhexidine alone can be justifiable when performing procedures with a low incidence and low grade of bacteremia in low-risk patients.[4]

Povidone-iodine is a water-soluble combination of molecular iodine and the solubilizing agent polyvinyl-pyrrolidone. This iodophor has a bactericidal effect similar to that of pure iodine; is effective against most of the bacteria, including putative periodontal pathogens, fungi, mycobacteria, viruses, and protozoa; fails to initiate sensitivity reactions or allow the development of bacterial resistance; and allows for a slow release of iodine, which ensures the establishment of an optimal, nontoxic concentration at a bactericidal level.[12] The usual procedure is oral rinsing with chlorhexidine or povidone-iodine for one to two minutes before the dental procedure.[12]

[a] Assistant Professor, Department of Orthodontics, Faculty of Dentistry, Selcuk University, Konya, Turkey.

[b] Research Fellow, Department of Orthodontics, Faculty of Dentistry, Selcuk University, Konya, Turkey.

[c] Associate Professor, Department of Conservative Dentistry, Faculty of Dentistry, Selcuk University, Konya, Turkey.

[d] Assistant Professor, Pediatric Dentistry, Ondokuz Mayis University, Samsun, Turkey.

[e] Assistant Professor, Pediatric Dentistry, Faculty of Dentistry, Selcuk University, Konya, Turkey.

Corresponding author: Siddik Malkoc, DDS, PhD, Department of Orthodontics, Selcuk University, Kampus, Konya 42075, Turkey (e-mail: siddikmalkoc@yahoo.com).

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Filler et al[13] determined the shear bond strength (SBS) of composite bonded to chlorhexidine-treated and untreated enamel. They demonstrated that the differences between SBS for the control and the experimental groups were not significant. Also the results of this study indicate that the use of antibacterial rinse would not compromise composite bond strengths, other parameters such as microleakage may be affected by interaction of chlorhexidine with the enamel-bonding surface. Bishara et al[14] and Damon et al[15] determined the effects of chlorhexidine varnish on the bond strength of orthodontic adhesives on the etched enamel surface. Bishara et al[11] also indicated that SBS is not significantly affected when chlorhexidine is applied if the varnish is premixed with the sealant and applied on the etched enamel surfaces and then light cured.

In the orthodontic literature, there is little or no information about the use of mouthwash forms of povidone-iodine. There also are limited studies on the chlorhexidine mouth rinse on bonding to the enamel before placing the bracket. Even though applying chlorhexidine to the enamel surface could add an increased protection around the bracket periphery against bacteria, it could also influence the bond strength adversely, depending on the method of application.

Therefore, the purpose of this study was to determine whether the application of chlorhexidine and povidone-iodine to the etched and unetched enamel affects the SBS of an orthodontic resin composite.

MATERIALS AND METHODS

Human mandibular incisors extracted because of periodontal reasons were stored at +4°C in physiological saline solution. Teeth with hypoplastic areas, cracks, or gross irregularities of the enamel structure were excluded from this study. The criteria for tooth selection dictated no pretreatment with a chemical agent such as alcohol, formalin, hydrogen peroxide etc. The teeth were removed from soft tissue remnants, calculus, and cleaned with fluoride-free pumice and rubber cup. Eighty-five teeth were selected for this study.

The roots of the teeth were cut with a water-cooled diamond disk and the crowns mounted in a 3-cm-diameter circle mold using chemically cured acrylic resin. The crowns were mounted so that their vestibule faces were perpendicular to the base of the molds. Before starting bonding procedure, the surface of the each tooth was polished for one minute using the combination of a polishing agent and a brush at a low speed (3000 rpm) in a contra angle handpiece.

The teeth were randomly distributed in four experimental groups and one control group, each containing 17 teeth. The chlorhexidine (0.2% chlorhexidine gluconate, Drogsan Pharmaceuticals, Ankara, Turkey) and povidone-iodine (7.5% povidone-iodine, Kansuk Pharmaceuticals, Istanbul, Turkey) were applied to the teeth under the following conditions.

FIGURE 1. Application apparatus of orthodontic composite on the enamel surface.

- Group 1, control group—no antibacterial mouthwash solution was used. A 37% orthophosphoric acid gel (3M Dental Products, St Paul, Minn) was used for 15 seconds for the acid etching of the teeth. The teeth were then rinsed with water for 15 seconds and dried with an oil-free air for 10 seconds. In all cases that were etched, the frosty white appearance of etched enamel was noticed. Orthodontic composite resin was then applied to enamel surface.
- Group 2—the samples were stored in 0.2% chlorhexidine solution for 60 seconds, rinsed with water for 10 seconds, and then etched for 15 seconds. Orthodontic composite resin was then applied to enamel surface using the same procedure of the control group.
- Group 3—the samples were kept in 7.5% povidone-iodine solution for 60 seconds, rinsed with water for 10 seconds, enamel surfaces were then etched, and the same procedures were applied as with the control group.
- Group 4—the teeth were etched for 15 seconds, rinsed, and placed in 0.2% chlorhexidine solution for 60 seconds. The solution was rinsed with water for 10 seconds, and orthodontic composite resin was applied as with the control group.
- Group 5—after etching, the teeth were placed in 7.5% povidone-iodine solution for 60 seconds. The samples were rinsed with water for 10 seconds, and composite resin was applied as with the control group.

An orthodontic bonding agent (Transbond XT, 3M Unitek, Monrovia, Calif) was used and light cured in all groups. An orthodontic composite resin was added to the surface by packing the material into the cylindrical plastic matrices with a 2.34-mm internal diameter and a three-mm height (Ultradent, South Jordan, Utah) (Figure 1). Excess composite was carefully removed from the periphery of the matrices with a dental explorer. Bonding agents and composites were cured with a HILUX (Benlioğlu Dental, Ankara, Turkey) curing light for 40 seconds. The intensity of the light was at least 400 mW/cm^2.

The specimens (Figure 2) were then stored in distilled water

FIGURE 2. Orthodontic composite block over enamel.

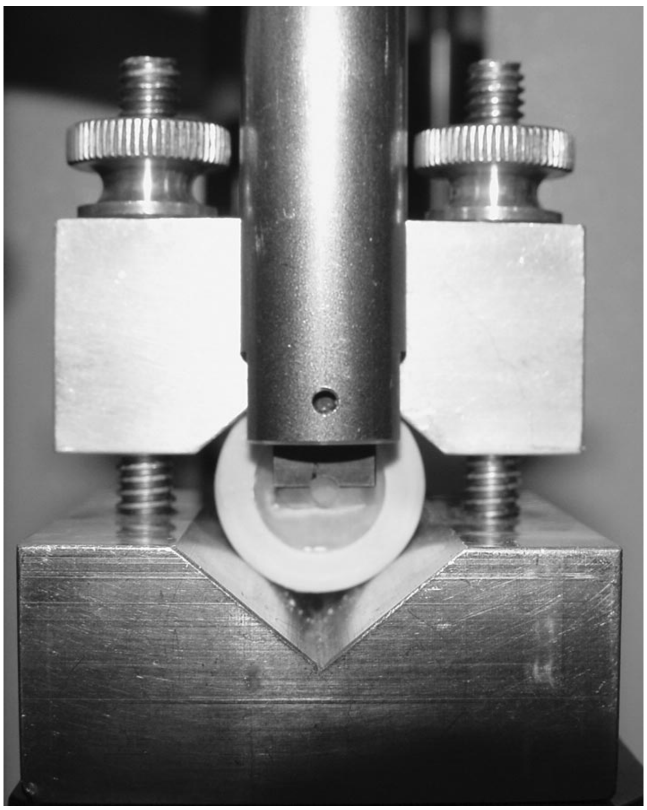

FIGURE 3. Application of force on composite block by the stub-shaped apparatus.

at 37°C for 24 hours before bond strength testing. For shear bond testing, the specimens were mounted in a universal testing machine (Model 500, Testometric, Lancashire, UK) (Figure 3). A notch-shaped apparatus (Ultradent) attached to a compression load cell at a crosshead speed of one mm/min was applied to each specimen at the interface between tooth and composite until failure occurred. The maximum load (N) was divided by the cross-sectional area of the bonded composite posts to determine SBS (in MPa).

TABLE 1. Mean ± SD (MPa) Shear Bond Strength Values and Statistical Comparison of Groups (n = 17)

Groups	Mean ± SD
Group 1	31.64 ± 3.62 A[a]
Group 2	34.33 ± 7.26 B
Group 3	36.56 ± 5.95 B
Group 4	30.00 ± 4.97 A
Group 5	30.26 ± 7.30 A

[a] According to Tukey honestly difference tests, means having same letter are not statistically different from each other ($P > .05$).

TABLE 2. Modes of Failure After Shear Bond Test[a]

	Adhesive (%)	Cohesive (%)	Mixed (%)
Group 1	16 (94.1)	1 (5.9)	—
Group 2	13 (76.5)	—	4 (23.5)
Group 3	13 (76.5)	1 (5.9)	3 (17.6)
Group 4	14 (82.4)	3 (17.6)	—
Group 5	15 (88.2)	2 (11.8)	—

[a] According to Mann-Whitney *U*-tests $P > .05$.

Fracture analysis

Fracture analyses were performed using an optical stereomicroscope (Olympus SZ4045 TRPT, Osaka, Japan). Failures were classified as cohesive if more than 80% of resin was found remaining on the tooth surface, adhesive if less than 20% of the resin remained on the tooth surfaces, or mixed if certain areas exhibited cohesive fracture, whereas other areas exhibited adhesive fracture.

Statistical analysis

Descriptive statistics including the mean and standard deviation were calculated for each of the five groups. Comparisons of means were made using analysis of variance (ANOVA) and Tukey honestly significance tests. Fracture modes were analyzed by Mann-Whitney *U*-test.

RESULTS

The descriptive statistics, including the mean and standard deviation, and statistical comparisons for each group are shown in Table 1. The results of ANOVA revealed statistically significant differences in bond strengths among the groups ($P \leq .05$).

When povidone-iodine and chlorhexidine were applied before etching the enamel surface, it was shown that the SBS of the orthodontic composite resin was higher than that of control ($P \leq .05$). However, the application of a test solution on the etched surface did not affect the SBS of orthodontic composite resin when compared with control values ($P \geq .05$).

The fracture patterns of the specimens are given in Table 2. Mann-Whitney *U*-test was used to compare failures among themselves in all groups. In general, a greater percentage of the fractures were adhesive failures at the tooth-composite junction ($P \geq .05$).

DISCUSSION

This study was undertaken to test the effects of different mouth rinse applications on the SBS. The results of this study indicate that the application of 0.2% chlorhexidine and 7.5% povidone-iodine on the enamel surface, either before or after etching, did not adversely affect the bond strength of the adhesive.

The effects of 0.2% chlorhexidine and 7.5% povidone-iodine after acid etching may be important when direct restorations are intended,[13] but in daily orthodontic practice, orthodontists do not acid etch the teeth and, before bonding the brackets, ask the patient to mouth rinse. In this case, not only will the mouth rinse solution bath the etched enamel, but a mixture of the mouth rinse and the patients' saliva, and this could affect the quality of bonding. However, 0.2% chlorhexidine or 7.5% povidone-iodine solution can be applied over the etched enamel surface and then rinse the teeth with water. Then, orthodontic composite resin can be applied over the etched enamel surface.

Filler et al[13] determined the SBS of composite bonded to chlorhexidine-treated and untreated enamel. In their study, the experimental group was immersed in 0.12% chlorhexidine gluconate for one minute, four times in a day, for seven days. The present study was in accordance with the study of Filler et al[13] showing that the SBSs of Prisma APH composite for the control and the experimental groups were not significantly different. The authors consider that the result may be attributed either to a lack of effects of chlorhexidine or to the acid etch that dissolves the affected superficial enamel, leaving an unaffected substrate for bonding.

The accelerated regimen of exposure should have provided higher concentrations of chlorhexidine or povidone-iodine than normally encountered in vivo. Three possible explanations could account for the lack of effects of chlorhexidine or povidone-iodine on the bond strength of the resin composite to enamel. First, if the enamel substrate was altered by chlorhexidine or povidone-iodine, then any significant changes may have been negated by the acid etch before bonding. Legler et al[16] determined the depth of etch in ground enamel caused by various concentrations and times of exposure of phosphoric acid by calculating the amount of calcium dissolved by acid etching and by using surface profilometry. They reported that a 37% phosphoric acid solution after a 30-second exposure resulted in an approximately 16-μm depth of etch. If chlorhexidine or povidone-iodine penetrated enamel to this extent or less, it may have been removed by the etching, negating any effect it might have had on the composite to enamel bond strength.

Second, although one might expect chlorhexidine or povidone-iodine to affect surface enamel based on diffusion and adsorption studies of other substance, eg, fluoride,[17] molecular size may influence the effects of a substance on enamel. For example, the fluoride ion is small enough to replace hydroxyl groups in the hydroxyapatite crystal. This reduces the crystallite size, which decreases solubility in the presence of acid. However, the chlorhexidine and povidone-iodine molecules are significantly larger than the fluoride ion, and hydroxyapatite crystals in the superficial enamel may be less affected by chlorhexidine and povidone-iodine because of molecular spatial relationship. Finally, chlorhexidine or povidone-iodine may have been absorbed by the enamel but were then released into the distilled water during storage between rinses.[13]

In our study, SBS values were at a very high level when compared with the previous bonding studies. In the current study, a different protocol was used for shear testing compared with previous studies to eliminate some critical aspects of the testing protocols affecting the outcome. For instance, the bracket base design may contribute to the misalignment of load application during testing, making the bonding system prone to failure, introducing variations that depend on the stress gradients generated. It has also been found that variability exists among the manufacturers with respect to the design or dimensions of the brackets in nominally identical prescriptions.[18] This variability poses a significant problem in studies evaluating bracket bond strength.[19] Because the thickness of the adhesive layer is small, the tips of the blades could not be accurately placed on it once the force was applied. The tips of blades may deviate toward the joint between the adhesive and the bracket base or between the adhesive and the enamel, which may significantly affect the results. Blunting of blades during use, particularly the pointed ones, would have increased the force level applied on later specimens. For these reasons, we used only orthodontic composite blocks without bonding a bracket for shear bond test.

Most of the orthodontic bonding studies have shown mixed- or cohesive-type failure.[20–22] After SBS testing, a part of the composite resin has remained on either the enamel surface or on the bracket base. Therefore, the SBS values obtained are cohesive failure of orthodontic composite rather than adhesive failure between enamel and composite resin. Because brackets were not used in the present study, adhesive failures were obtained between enamel and the orthodontic composite. Therefore, real SBS values between enamel and composite were measured rather than cohesive failure in composite.

Thorough plaque and inflammation control is very difficult in patients with fixed orthodontic appliances, and the use of chemical agents in the form of mouth rinses or oral sprays has been shown to be useful adjuncts. Mouth rinses could be helpful in orthodontic patients for suppressing oral mutans or other microbe levels when the rinses are used before the placement of fixed orthodontic appliances.[23]

Jentsch et al[24] performed a transmission electron microscopic study to verify the influences of mouth rinses on dental plaque. Their study showed that rinsing with chlorhexidine digluconate without any additional oral hygiene procedure resulted in a continuous significant decrease in plaque thickness. The authors suggested that the application of chlorhexidine digluconate solutions is beneficial for the plaque control in the oral cavity. The mechanism of action of a chlorhexidine mouthwash seems to be an immediate and probably short-lived bactericidal effect, followed by a prolonged bacteriostatic action that is dependent on antiseptic absorbed by the pellicle coating tooth surface.[25] Application of antiseptic mouthwashes before orthodontic banding-bonding may reduce the incidence and severity of bacteremia[26,27] as well as may reduce enamel demineralization around the orthodontic band or bracket bases.[28]

The orthodontist has concerns about bacteremia and dental caries development during fixed orthodontic treatment. The application of antibacterial mouth rinses takes a small amount of clinical chair time and can be accomplished by staff personnel, without any significant decrease in bond strength of the orthodontic composite resin to enamel surface.

CONCLUSIONS

Treating enamel with both 0.2% chlorhexidine and 7.5% povidone-iodine significantly increased SBS. However, the applications of 0.2% chlorhexidine and 7.5% povidone-iodine do not significantly affect the bond strength to the etched enamel surface. As a result, the use of 0.2% chlorhexidine and 7.5% povidone-iodine mouth rinses to clean the teeth before acid etching can be recommended as part of the bonding protocol.

Further clinical studies have to be planned to test whether these mouth rinses can prevent white spot lesions or dental caries.

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