Original Article

Waterline Disinfectant Effect on the Shear Bond Strength of Orthodontic Brackets

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Abstract: The purpose of this study was to determine whether the use of an iodine compound for disinfecting the waterlines in dental units has an effect on the shear bond strength of orthodontic brackets bonded to enamel. Forty molar teeth were divided randomly into two groups—group 1 control: twenty teeth were etched for 15 seconds with 35% phosphoric acid, washed with a distilled water spray for 10 seconds, stored in distilled water for 5 minutes, dried to a chalky white appearance, and the sealant applied to the etched surface; group 2 experimental: twenty teeth were etched for 15 seconds with 35% phosphoric acid and washed for 10 seconds with water containing iodine. The teeth were stored for five minutes in the iodinated water, dried to a chalky white appearance, and the sealant applied to the etched surface as in the control group. Precoated brackets were placed on all the teeth and light cured for 20 seconds. All teeth were debonded within 30 minutes from the initial time of bonding. The *t*-test results ($t = 1.74$) indicated that there were no significant ($P = .09$) differences in the shear bond strengths of the teeth that were washed and immersed in the iodine solution and the control group in which distilled water was used. The mean shear bond strengths for the two groups were 6.5 $\pm$ 3.5 MPa and 4.7 $\pm$ 3.1 MPa, respectively. (*Angle Orthod* 2005;75:1032–1035.)

Key Words: Disinfectant; Waterlines

INTRODUCTION

The quality of water passing through the waterlines of the dental units is of primary concern to clinicians because both the patient and the office staff are exposed to the aerosols generated during the various clinical procedures.[1] The concern is related to both the chemical and particle contents of the water as well as the bacterial count in the waterline.[2–4]

For a number of years, it has been ascertained that water delivered from the dental units during routine dental procedures is highly contaminated by numerous species of pathogen and nonpathogen microorganisms, which enter the dental units by being retracted up from the oral cavity of patients undergoing dental treatment.[2]

The biofilm, which is derived from bacteria in the incoming water and is intrinsically resistant to most biocides, is the primary reservoir for continued contamination of the system.[1] Biofilm forms a tenacious layer that is strongly adherent to the walls of the tubing and often contains different types of pathogenic bacteria.[3]

In 1996, the American Dental Association established a goal for dental water quality and specified that it should not contain more than 200 colony forming units per milliliter (CFU/mL).[2,4] On the other hand, Lingr et al found that untreated dental unit waterlines may contain up to 9760 CFU/mL.[5] Because of such significant levels of contamination, the use of intraoperative antimicrobial agents have been implemented either to be placed in the unit waterline or used topically after cavity preparation.[6]

Numerous chemicals for use in disinfecting dental waterlines have been suggested.[7] Lingr et al[5] found that hydrogen peroxide–based dental unit waterline treatment reduced colonization from 9760 CFU/mL to

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200 CFU/mL in one week. By four weeks, the count was reduced to 0 CFU/mL. Meiller et al[8] found that the use of Listerine Antiseptic for 18 hours rendered biofilm samples free of recoverable bacteria.

Other chemicals for disinfecting dental waterlines have been used, including sodium hypochlorite, glutaraldehyde, chlorhexidine, iodine, and Sterilox, which is superoxidized water. All these chemicals were found to be effective in reducing bacterial biofilm.[9–11]

Mc Fadden et al[6] found that the use of chlorhexidine or glutaraldehyde during the bonding procedure with All-Bond 2 increased its shear bond strength to dentin. Knight et al[7] found no significant difference in shear bond strengths of resin-based composite to tooth structure when rinsed with distilled water as compared with those rinsed with distilled water mixed with mouthwash. On the other hand, Taylor-Hardy et al[12] suggested that dental unit waterline biocides might adversely affect adhesion of resin to enamel.

Because of these controversial findings, it is important for the orthodontists to know whether the bond strength will be affected by using water containing an antibacterial agent. The purpose of this study was to determine whether disinfecting the waterlines in the dental units with an iodine compound will affect the shear strength of orthodontic brackets bonded to enamel.

MATERIALS AND METHODS

Teeth

Forty freshly extracted human molars were collected and stored in a solution of 0.1% wt/vol thymol. The criteria for tooth selection included: intact buccal enamel, not subjected to any pretreatment chemical agents such as hydrogen peroxide, no cracks due to the pressure of the extraction forceps, and no caries. The teeth were cleansed and polished with a pumice slurry and rubber prophylactic cups for 10 seconds. All teeth were thoroughly washed and dried.

Brackets used

Forty maxillary right central incisor precoated brackets (APC Victory Series, 3M Unitek, Monrovia, Calif) were used. The average surface area for the bracket base was 12.2 mm^2. The surface area was the average obtained from measuring five brackets. The small and flat central incisor bracket base provides the best fit to the flat part of the buccal surface of the molar tooth.

Bonding procedure

Transbond XT adhesive system (3M Unitek) was used to bond brackets in both groups. Transbond XT is a light-cured composite adhesive material.

The forty teeth were randomly divided into two groups:

- Group 1 control (rinsed with distilled water): Twenty teeth were etched for 15 seconds with 35% phosphoric acid, washed with a distilled water spray for 10 seconds according to the manufacturer's instructions. The teeth were then stored in distilled water for five minutes, dried to a chalky white appearance, and the sealant applied to the etched surface. The precoated brackets were then placed on the teeth and light cured with a halogen light for 20 seconds.
- Group 2 experimental (rinsed with water containing iodine): Twenty teeth were etched for 15 seconds with 35% phosphoric acid and washed for 10 seconds with a water spray containing iodine. The water was obtained from a dental unit in which the antibacterial agent Denta Pure (MRLB International Inc, Fergus Falls, Minn) was used. Denta Pure is an iodinated resin cartridge formed of 46% iodine bound to a strong base anion exchange resin as the active ingredient and 54% other ingredients. The teeth were stored for five minutes in the iodinated water, dried to a chalky white appearance, and the sealant applied to the etched surface as in the control group. The purpose of soaking the etched teeth for a five-minute period was to magnify the effect of the iodinated water on the etched enamel. The precoated brackets were then placed on the teeth and light cured with a halogen light for 20 seconds.

After placing the brackets on each tooth but before light curing, a 300-g force was applied using a force gauge (Correx, Bern, Switzerland) to ensure a uniform adhesive thickness.

Shear bond strength testing

The teeth were embedded in acrylic in phenolic rings (Buehler Ltd, Lake Bluff, Ill). A mounting jig was used to align the facial surface of the tooth to be perpendicular with the bottom of the mold and its labial surface parallel to the force during the shear strength test. Within 30 minutes from the initial bonding, an occlusogingival load was applied to each bracket producing a shear force at the bracket-tooth interface. This was accomplished by using the flattened end of a steel rod attached to the crosshead of a Zwick Universal Test Machine (Zwick GmbH & Co, Ulm, Germany). A computer electronically connected to the Zwick test machine recorded the results of each test in megapascals (MPa). Shear bond strengths were measured at a crosshead speed of 5.0 mm/min.

Statistical analysis

Descriptive statistics including the mean, standard deviation, minimum and maximum values were cal-

TABLE 1. Descriptive Statistics (in Megapascals) and *t*-test Results Comparing the Shear Strength of Brackets Bonded to Teeth Washed With a Disinfectant Solution and a Control Group Washed With Distilled Water[a]

Rinsing Solutions	Mean	SD	Range
Water + Iodine Disinfectant	6.5	3.5	2.5–17.7
Distilled Water	4.7	3.1	1.0–11.1

[a] $t = 1.74$; $P = .09$.

culated for the two groups evaluated. Student's *t*-test was used to compare the shear bond strengths of the two groups. Significance was predetermined at $P \leq .05$.

RESULTS

The descriptive statistics and the results of the shear bond strength test comparisons between the two groups are presented in Table 1.

The *t*-test results ($t = 1.74$) indicated that there were no significant ($P = .09$) differences in the shear bond strengths of the teeth that were washed and immersed in the iodine solution used to disinfect the waterlines in the dental units and of a control group washed and immersed in distilled water. The mean shear bond strength for the iodine group was 6.5 ± 3.5 MPa and for the control group 4.7 ± 3.1 MPa.

DISCUSSION

Concerns with the presence of a biofilm in the waterlines of dental units have led the American Dental Association to recommend a 200 CFU/mL limit on the bacterial count permissible in dental operatories.[2,4]

A number of antibacterial products have been effective in significantly reducing or eliminating such a biofilm from the waterline.[6–11] On the other hand, for these products to be widely used in dental offices, they need to be safe to the patient as well as to those working in the dental operatory, relatively simple to install, should not have an objectionable taste or color, be cost effective, and, as important, should not adversely effect the working characteristics and properties of the materials used in the different dental procedures, including the adhesive used for bonding orthodontic brackets to the teeth.

As a result, a number of antibacterial agents have been successfully introduced in the market to meet these requirements.[5–12] Denta Pure is an iodine base compound that is used as an antibacterial agent to control the biofilm in the waterlines of all the dental units at the College of Dentistry at the University of Iowa. The presence of such a compound in the water that is used during the various steps of the bonding procedure should be of concern to clinicians particularly because the literature is ambiguous as to whether such chemicals do[12] or do not[6,7] affect the bond strength of the adhesives to the tooth structures.

The present findings indicated that the use of an iodine base antibacterial agent in the waterlines did not affect the shear bond strength of the orthodontic brackets to enamel. As a result, at least from an orthodontic perspective, there are no contraindications for using such a compound in the dental operatory to disinfect the waterlines.

CONCLUSIONS

The waterlines in dental units need to be continuously disinfected with various solutions to maintain the bioflora at acceptable levels. The use of an iodine compound for such a purpose did not affect the shear bond strength of brackets bonded to teeth that were washed and immersed in the disinfectant solution.

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