Original Article

Effect of Antimicrobial Monomer–Containing Adhesive on Shear Bond Strength of Orthodontic Brackets

Samir E. Bishara[a]; Manal Soliman[b]; John Laffoon[c]; John J. Warren[d]

Abstract: A new antibacterial and fluoride-releasing bonding system consists of a self-etching primer that contains an antibacterial monomer and a bonding agent that contains sodium fluoride. This study was to determine the effect of using this new adhesive on the shear bond strength of orthodontic brackets. Forty molar teeth were randomly divided into two groups. Group 1 consisted of 20 teeth that were etched for 15 seconds with 35% phosphoric acid, washed with a water spray for 10 seconds, and dried to a chalky white appearance, and the sealant was applied to the etched surface. The precoated brackets were placed on the teeth and light cured. Group 2 consisted of 20 teeth that were etched with 35% phosphoric acid for 15 seconds as suggested by the manufacturer when bonding to intact enamel. The teeth were washed with a water spray for 10 seconds and dried to a chalky white appearance, and the primer containing antibacterial monomer was applied to the etched surface, left for 20 seconds, and sprayed with a mild airstream. The adhesive was applied to each tooth, and the precoated bracket was placed and light cured. There were no significant differences ($P = .220$) in the shear bond strengths of the two groups. The mean shear bond strength for the antibacterial fluoride-releasing adhesive was 11.7 ± 5.6 MPa and for the control was 9.6 ± 5.0 MPa. The use of an antibacterial fluoride-releasing adhesive system did not affect the shear bond strength of the orthodontic brackets within the first half hour after initial bonding. (*Angle Orthod* 2005;75:397–399.)

Key Words: Antimicrobial agents; Adhesives; Orthodontic brackets; Shear bond strength

INTRODUCTION

Placement of fixed orthodontic appliances normally causes an increase in oral colonization by *mutans streptococci*, which in turn increases the risk for the development of dental caries.[1] Caries development in the form of white spot lesions on the labial surfaces of the teeth, particularly maxillary incisors, is an esthetic side effect of treatment with fixed orthodontic appliances.[2] For an effective remineralization process, it is necessary to control the bacterial biofilm around the brackets and maintain a constant presence of fluoride in the oral cavity.[3] Øgaard and Rølla[4] found that at pH four in the plaque-surrounding orthodontic brackets, the remineralization process will be adversely affected and even the introduction of additional fluoride in the oral environment will not necessarily result in a better cariostatic effect.

The practice of orthodontics is constantly improving with the use of new techniques and materials that benefit both the patient and the clinician. As a result, various attempts have been made to minimize white spot lesion formation during orthodontic treatment.[2,5–7] In a study by Øgaard et al[2] they found that with the use of a fluoride varnish in combination with and without the use of a chlorhexidine varnish, there was a significant reduction in the incidence of white spot lesion formation particularly in the maxillary incisor region. Buyukyilmaz and Øgaard[5] in an earlier study suggested the use of antimicrobials in combination with fluorides to improve the cariostatic effect of fluoride.

A new antibacterial and fluoride-releasing bonding system has recently been developed and introduced in the market. This system consists of a self-etching primer that contains an antibacterial monomer (12-methacryloyloxydodecyl pyridinium bromide [MDPB]) and a bonding agent that contains sodium fluoride.[7] This study determines the effect of using this new adhesive system on the shear bond strength of orthodontic brackets.

[a] Professor, Orthodontic Department, College of Dentistry, University of Iowa, Iowa City, Iowa.

[b] Visiting Fellow, Department of Operative Dentistry, College of Dentistry, University of Iowa, Iowa City, Iowa.

[c] Research Assistant, College of Dentistry, University of Iowa, Iowa City, Iowa.

[d] Associate Professor, Department of Preventive and Community Dentistry, University of Iowa, Iowa City, Iowa.

Corresponding author: Samir E. Bishara, BDS, DDS, DOrtho, MS, Orthodontic Department, College of Dentistry, S219 DSB, University of Iowa, Iowa City, IA 52242
(e-mail: karla-starckovich@uiowa.edu).

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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 then 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 II, Victory Series lot Z7707NK, 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 the width and height of five bracket bases. The calculated differences between the bracket surface areas did not exceed 0.08 mm.

Bonding procedure

The 40 teeth were randomly divided into two groups.

Group 1—Control (Transbond XT adhesive system). Twenty teeth were etched for 15 seconds with 35% phosphoric acid, washed with a water spray for 10 seconds, and dried to a chalky white appearance, and the sealant was applied to the etched surface. The precoated (APC II 3M Unitek, Monrovia, CA) bracket was then placed on the tooth and light cured with a halogen light (Ortholux XT, 3M Unitek, Monrovia, CA) for 20 seconds.

Group 2 (Clearfil Protect Bond). Twenty teeth were etched with 35% phosphoric acid for 15 seconds as suggested by the manufacturer when using the product on intact enamel. The teeth were then washed with a water spray for 10 seconds, and dried to a chalky white appearance, and the primer containing the antibacterial monomer (Kuraray Medical Inc, Okayama, Japan) was applied to the etched surface, left for 20 seconds, and sprayed with a mild airstream to evaporate the solvent. The fluoride-containing adhesive was applied to the tooth, and the precoated bracket was placed and light cured with a halogen light for 20 seconds.

After placing the brackets on each tooth at room temperature, a 300-g force was applied for five seconds 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 to the bottom of the mold and its labial surface parallel to the force during the shear strength test. Within half an hour 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 0- to 500-kg load cell was used in this study. 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.

TABLE 1. Descriptive Statistics and the Results of Student's *t*-Test Comparing the Shear Bond Strength (in MPa) of Two Adhesive Systems: An Antibacterial Fluoride-Releasing System and a Conventional System

Adhesive Systems	Mean	SD	Range
Clearfil Protect Bond	11.7	5.6	3.9–22.5
Transbond XT	9.6	5.0	2.8–18.5
	$t = 1.248$	$P = .220$	

Statistical analysis

Descriptive statistics including the mean, standard deviation, and minimum and maximum values were calculated for the two groups evaluated. Student's *t*-test was used to compare the shear bond strengths of the two adhesive systems. Significance was predetermined at $P \leq .05$.

RESULTS

The descriptive statistics and the results of the Student's *t*-test comparing the antibacterial fluoride-releasing and control adhesive systems are presented in Table 1.

The *t*-test results ($t = 1.248$) indicated that there were no significant differences ($P = .220$) in the shear bond strengths of the two systems. The mean shear bond strength for the antibacterial fluoride-releasing adhesive was 11.7 ± 5.6 MPa and for the control adhesive was 9.6 ± 5.0 MPa.

DISCUSSION

The practice of orthodontics is constantly improving with the use of new techniques and materials that benefit both the patient and the clinician. As a result, various attempts were made to minimize white spot lesion formation during orthodontic treatment.[2,5–7] In a study by Øgaard et al[2] they found that with the use of a fluoride varnish in combination with and without a chlorhexidine varnish, there was a significant reduction in the incidence of white spot lesion formation.

In this study, the use of the newly introduced antibacterial fluoride-releasing adhesive did not significantly affect the shear bond strength of orthodontic brackets to enamel. Actually, the mean shear bond strength tended to be higher

when compared with the control group bonded with a conventional adhesive system.

It needs to be noted that with the use of the new antibacterial fluoride-releasing adhesive, the clinician needs to perform one additional step during the bonding procedure as compared with the conventional system. The increase in chair time should be balanced with the potential advantage of using an antibacterial fluoride-releasing adhesive that could minimize the incidence of white spot formation.

CONCLUSIONS

- The use of an antibacterial fluoride-releasing adhesive system did not affect the shear bond strength of the orthodontic brackets within the first half hour after initial bonding.
- The advantage of using the new system with its antibacterial fluoride-releasing properties should be considered with the understanding that the clinician needs to perform an additional step during the bonding procedure when compared with a conventional bonding system.

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