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ORIGINAL RESEARCH

The Impact of Chlorhexidine Mouth Rinse on the Bond Strength of Polycarbonate Orthodontic Brackets

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ABSTRACT

Objective: The purpose of the current in-vivo study was to assess the effect of using 0.12% chlorhexidine (CHX) mouth rinse, before bonding, on shear bond strength of polycarbonate brackets bonded with composite adhesive.

Subjects and methods: Eighteen orthodontic patients with a mean age 21.41 ± 1.2 years, who were scheduled to have 2 or more first premolars extracted, were included in this study. Patients were referred for an oral prophylaxis program which included, in part, the use of a mouth rinse. Patients were divided into 2 groups, a test group of 9 patients who used 0.12% CHX gluconate mouth rinse twice daily and a control group of 9 patients who used a mouth rinse without CHX, but with same color. After 1 week, polycarbonate brackets were bonded to first premolars with Transbond XT composite adhesive. Premolars were extracted after 28 days and tested for shear bond strength on a universal testing machine. Student's t-test was used to compare shear bond strengths of both groups.

Results: No statistically significant difference was found in bond strengths' values between both groups. The test group (with CHX) has mean shear bond strength of 14.21 ± 2.42 MPa whereas the control group (without CHX) revealed a mean strength of 14.52 ± 2.31 MPa.

Conclusion: The use of 0.12% CHX mouth rinse, for one week before bonding, did not affect the shear bond strength of polycarbonate brackets bonded with Transbond composite. Furthermore, these brackets showed clinically acceptable bond strength.

Keywords: Chlorhexidine, Polycarbonate brackets, Composite adhesive, Shear bond strength.

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INTRODUCTION

The changes in the oral environment as a consequence of fixed orthodontic appliance therapy favors the accumulation of dental plaque around the brackets leading to white spot lesions, dental caries and periodontal problems.[1,2] Various preventive approaches have been reported in the literature to control caries and periodontal disease during the orthodontic therapy.[3] Agents such as toothpastes and gels, varnishes and sealants, topical fluoride preparations, fluoride-releasing agents or fluoride-releasing bonding materials, antimicrobial agents mixed with orthodontic adhesives, or combinations of self-etching primer and fluoride-releasing adhesives were tried to control caries and demineralization in orthodontic patients.[4,5]

Antimicrobial agents are usually prescribed as an adjunct to conventional therapy for reducing bacterial plaque accumulation and enamel demineralization during treatment.[6-9] Chlorhexidine (CHX) is one of the most widely used antibacterial agents in dentistry. It has been proven to be effective for plaque control and as an adjunct treatment for periodontal diseases.[8,10-12]

Although, applying CHX to the enamel surface can increase antibacterial protection, it could adversely affect bond strength of orthodontic brackets. These effects have been assessed with toothpastes, varnishes, after initial prophylaxis, and incorporating the CHX in the primer or sealant.[13-16] In addition, the effect of application of different CHX formulations on etched enamel surfaces before bonding was assessed earlier.[17] These *in vitro* studies showed contradictory findings indicating that applying CHX to enamel surface before bonding can interfere with bond strength of metallic brackets.[13,17-21]

The orthodontic bracket must be able to sustain loads of 5.9 to 7.8 MPa to be considered clinically successful for orthodontic purposes.[22] The most common method of testing the strength of orthodontic adhesives is shear testing. In shear testing, a force is directed parallel to the

long axis of the tooth and as close to the bracket– tooth interface as possible.[23]

Even though several studies were done on extracted human and bovine tooth, there could be factors that might influence the effects of these materials in the oral cavity such as temperature, humidity and pH etc.[24,25] There is limited information available on the *in vivo* effect of CHX on bond strength for non-metallic brackets. Hence the present study is conducted to evaluate the effect of 0.12% CHX oral rinse on the bonding of polycarbonate brackets. The shear bond strength was assessed by determining the load applied to remove the brackets using a universal testing machine.

MATERIALS AND METHODS

A total of 18 consecutive orthodontic patients with a mean age 21.41 ± 1.2 years (age range 17 to 24 years) were enrolled in the study. The participants were selected from patients seeking orthodontic treatment in the Outpatient clinic, Orthodontic Department, Faculty of Dental Medicine, Al-Azhar University, Cairo, Egypt. Orthodontic patients who were scheduled for therapeutic extraction of at least 2 first premolars as part of their treatment were included in the study. The study details were explained to the patients and a signed consent was obtained from all participant's/parent to be included in the study. The ethical clearance was obtained from the Institutional review board.

All participants were referred for an oral prophylaxis program which included, in part, the use of commercially available mouth rinse for 7 days before bonding. The study was organized as a parallel group design with one group receiving a test mouth rinse and the other group acting as a control. The participants were randomized into both groups by using random number tables according to a previously described method[26] The test group included 9 patients, who were asked to rinse for 30 seconds with 20 ml of 0.12% CHX gluconate (Peridex, Proctor and Gamble, Cincinnati, Ohio). On the other hand, the control group included 9 patients, who were asked to rinse the mouth for 30 seconds with 20 ml of placebo mouth rinse with a similar color.

Both mouth rinses were stored in 120 ml numbered plastic bottles and were given to the patients by an operator not directly involved in the study. A double blinding method was used regarding the mouth rinse used by the patient.

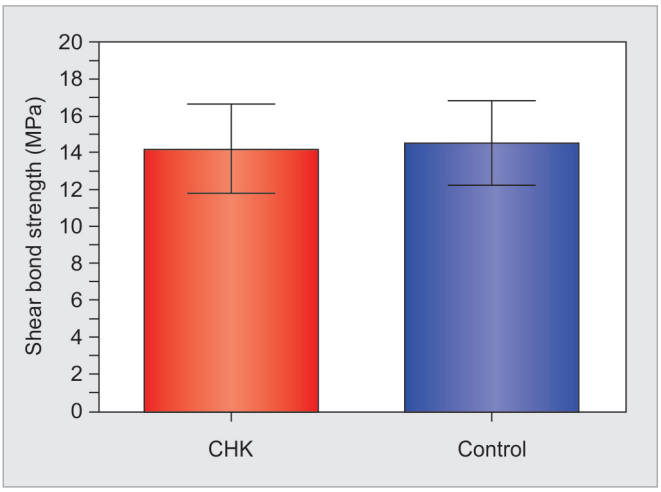
After 1-week interval, direct bond standard edgewise (0.022 × 0.028 inches slot) stainless steel brackets (American Orthodontics Corp, USA) were bonded for all teeth, except first premolars indicated for extraction, and molars bands (Ormco, Orange, California, USA) were cemented for each patient enrolled in this study of both groups. A direct bond standard edgewise (0.022 × 0.028 inches slot) polycarbonate bracket (Trianeiro, Ind Comp Exp, Ltda, Brazil) was bonded to the first premolars (Fig. 1).

The surface of each tooth was polished for 1 minute using a water and pumice, then rinsed and dried. The enamel surface was then etched for 30 seconds using a 37% phosphoric acid gel (3M Dental Products, St Paul, Minn). After acid etching, all brackets were bonded, with light-cured adhesive (Transbond XT system, 3M Unitek, Monrovia, Calif) according to manufacturer's directions. A firm pressure was used to completely seat brackets on to the teeth and the excess adhesive was removed with a sharp scaler. Then all brackets were light-cured with a light-curing unit (Blue phase C5, Ivoclar Vivadent, Liechtenstein, Austria) for 40 seconds, 10 seconds each from the mesial, distal, gingival and occlusal margins.

Twenty eight days following brackets' bonding, the first premolars were extracted then washed and cleansed of soft tissue with curettes and stored in a solution of 0.1% thymol. The specimens were mounted in custom made Teflon rings (15 mm height and 10 mm in diameter) with fast-setting acrylic resin (Acrostone, Acrostone Dental Factory, Cairo, Egypt). The bracket base surface area was determined to be 13.63 mm^2 with a digital caliper (Guanglu Measuring Instrument Co., China).

An Instron universal testing machine (Lloyd Instruments, Fareham, UK) was used to apply a load to the bracket, which produced a shear force at tooth-bracket interface. A computer connected to the machine recorded the results of each test (Nexygen software). Shear bond strengths were measured at a crosshead speed of

Fig. 1: Intraoral photographs of a patient showing polycarbonate brackets bonded to first premolars prior to the extraction



Graph 1: Mean shear bond strength (in MPa) of test (n = 17 specimens) and control (n = 16 specimens) groups

0.5 mm/min. The maximum force required to take off the brackets was measured in Newtons, and the shear bond strength was calculated, in megapascals (MPa), by dividing force values by bracket base area (one MPa = one N/mm^2).

STATISTICAL ANALYSIS

The data were statistically analyzed using Statistical Package for Social Sciences (SPSS, version 15, Inc, Chicago, Ill). The data of bond strength of composite adhesive were tested for normality with the Shapiro-Wilk method and were found to be normally distributed with homogeneity of variance between groups. The statistical evaluation of bond strength was performed using parametric tests. Descriptive statistics were calculated for each group and Student's t-test was used to compare shear bond strengths of both groups. Significance was determined at $p \leq 0.05$ level.

RESULTS

During the study, few brackets were lost due to debonding, during extraction procedures and testing. Thus, 17 first premolars within the test group and 16 in the control group were evaluated. Table 1 depicts the shear bond strengths, for both groups. The analysis indicated that the test group (with CHX) had a mean shear bond strength of 14.21 ± 2.42 MPa whereas the control group (without CHX) has mean shear bond strength of 14.52 ± 2.31 MPa.

Table 1: Descriptive statistics of shear bond strengths (in MPa) of the 2 groups

Groups	*Mean*	*SD*	*t-value*	*p-value*
Test group (n = 17 specimens)	14.21	2.42		
Control group (n = 16 specimens)	14.52	2.31	0.36	NS

n: Number; SD: Standard deviation; NS: Not significant p > 0.05

Comparison of the two groups using t-test revealed no statistically significant differences in bond strengths (p = 0.73) between the two tested groups (Table 1 and Graph 1).

DISCUSSION

The study was conducted to assess the impact of CHX mouth rinse on the bonding of polycarbonate brackets. We found that there is no significant differences in both control and study groups. The group which used CHX for a week prior to the fixing of polycarbonate did not influence the shear bond strength. This observation is in agreement with the earlier reports.[13,16,18,20] Most of the earlier reports were done in *in vitro* models. A direct comparison of the present experiment is not possible due to the variation in the experimental design and the materials used.[24,25]

The ceramic and polycarbonate brackets are esthetically superior but have some functional and mechanical limitations. More recently, polycarbonate brackets have been reinforced with a ceramic filler, which was hypothesized to prevent the brackets from staining and improving their strength.[27-29] However little information is available about its clinical performance.

Although, it was not the main objective of the current study, it is important to note that polycarbonate brackets bonded with Transbond composite showed clinically acceptable bond strength. The mean bond strengths for both groups ranged from 10.38 to 17.64 MPa (Table 1). Reynolds[22] suggested that a minimum bond strength of 6 to 8 MPa is adequate for most clinical orthodontic needs. These bond strengths are considered to withstand masticatory and orthodontic forces. In the study, the CHX did not influence the bonding of the brackets to the enamel. Two possible explanations for this has been proposed.[18] Firstly, if the enamel substrate was altered by CHX, then any significant changes might have been nullified by the acid etch during the bonding process. Legler et al[30] determined the depth of etch in ground enamel caused by various concentrations and times of exposure of phosphoric acid. They reported that 37% phosphoric acid solution after a 30 seconds exposure resulted in an approximately 16 µm depth of etch. So if CHX penetrated enamel to this extent or less, it might have been removed by the etching.

Secondly CHX molecules are significantly larger than fluoride ions and hydroxyapatite crystals and the enamel surface can not be affected by CHX because of the molecular spatial relationship.[18] Accordingly, the results of the present study could be attributed either to a lack of effect of CHX or to acid etching that dissolved

the affected superficial enamel, leaving an unaffected substrate for bonding.

Some studies have reported contradictory findings such as decrease in bond strength of Transbond composite when different CHX forms were applied *in vitro* as a layer over an etched enamel and immediately before bonding. They found bond strength values too low to be clinically acceptable.[13,17,19,21] However, these studies utilized different methodological designs as well as different CHX forms, brackets type, and bonding technique, on etched enamel, which could explain the disagreement among results.

Finally, while incorporation of CHX mouth rinse could be advantageous in controlling the bacterial biofilm,[7,9,10,31] several adverse effects of CHX mouth rinses have been reported, including a bitter taste, increased calculus deposition, and brown discoloration of teeth and tongue.[32] Further randomized controlled studies are needed to evaluate effects of prolonged use of CHX on shear bond strength, color stability of polycarbonate brackets, and possible side effects, before using CHX mouth rinse in daily clinical practice is fully warranted.

CONCLUSION

From the findings of the present study it can be concluded that 0.12% Chlorhexidine use prior to the bonding of polycarbonate brackets has no influence on the shear bond strength of the brackets. The polycarbonate brackets also achieved the clinically acceptable bond strength.

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REFERENCES

1. Scheie AA, Arneberg P, Krogstad O. Effect of orthodontic treatment on prevalence of Streptococcus mutans in plaque and saliva. Scand J Dent Res 1984;92(3):211-217.
2. Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. Am J Orthod 1982;81(2):93-98.
3. Ogaard B, Larsson E, Henriksson T, Birkhed D, Bishara SE. Effects of combined application of antimicrobial and fluoride varnishes in orthodontic patients. Am J Orthod Dentofacial Orthop 2001;120(1):28-35.
4. Tuncer C, Tuncer BB, Ulusoy C. Effect of fluoride-releasing light-cured resin on shear bond strength of orthodontic brackets. Am J Orthod Dentofacial Orthop 2009;135(1):14 e11-16; discussion 14-15.
5. Chadwick BL, Roy J, Knox J, Treasure ET. The effect of topical fluorides on decalcification in patients with fixed orthodontic appliances: a systematic review. Am J Orthod Dentofacial Orthop 2005;128(5):601-606.
6. Ong MM, Wang HL. Periodontic and orthodontic treatment in adults. Am J Orthod Dentofacial Orthop 2002;122(4): 420-428.
7. Zimmer BW, Rottwinkel Y. Assessing patient-specific decalcification risk in fixed orthodontic treatment and its impact on prophylactic procedures. Am J Orthod Dentofacial Orthop 2004;126(3):318-324.
8. Sari E, Birinci I. Microbiological evaluation of 0.2% chlorhexidine gluconate mouth rinse in orthodontic patients. Angle Orthod 2007;77(5):881-884.
9. Uysal T, Amasyali M, Koyuturk AE, Ozcan S. Effects of different topical agents on enamel demineralization around orthodontic brackets: an in vivo and in vitro study. Aust Dent J 2010;55(3):268-274.
10. Sudjalim TR, Woods MG, Manton DJ. Prevention of white spot lesions in orthodontic practice: a contemporary review. Aust Dent J 2006;51(4):284-289.
11. Derks A, Frencken J, Bronkhorst E, Kuijpers-Jagtman AM, Katsaros C. Effect of chlorhexidine varnish application on mutans streptococci counts in orthodontic patients. Am J Orthod Dentofacial Orthop 2008;133(3):435-439.
12. Nelson-Filho P, Valdez RM, Andrucioli MC, Saraiva MC, Feres M, Sorgi CA, et al. Gram-negative periodontal pathogens and bacterial endotoxin in metallic orthodontic brackets with or without an antimicrobial agent: an in-vivo study. Am J Orthod Dentofacial Orthop 2011;140(6):e281-287.
13. Bishara SE, Vonwald L, Zamtua J, Damon PL. Effects of various methods of chlorhexidine application on shear bond strength. Am J Orthod Dentofacial Orthop 1998;114(2):150-153.
14. Cacciafesta V, Sfondrini MF, Stifanelli P, Scribante A, Klersy C. Effect of chlorhexidine application on shear bond strength of brackets bonded with a resin-modified glass ionomer. Am J Orthod Dentofacial Orthop 2006;129(2):273-276.
15. Bishara SE, Damon PL, Olsen ME, Jakobsen JR. Effect of applying chlorhexidine antibacterial agent on the shear bond strength of orthodontic brackets. Angle Orthod 1996; 66(4):313-316.
16. Damon PL, Bishara SE, Olsen ME, Jakobsen JR. Bond strength following the application of chlorhexidine on etched enamel. Angle Orthod 1997;67(3):169-172.
17. Catalbas B, Ercan E, Erdemir A, Gelgor IE, Zorba YO. Effects of different chlorhexidine formulations on shear bond strengths of orthodontic brackets. Angle Orthod 2009;79(2):312-316.
18. Demir A, Malkoc S, Sengun A, Koyuturk AE, Sener Y. Effects of chlorhexidine and povidone-iodine mouth rinses on the bond strength of an orthodontic composite. Angle Orthod 2005;75(3):392-396.
19. Karaman AI, Uysal T. Effectiveness of a hydrophilic primer when different antimicrobial agents are mixed. Angle Orthod 2004;74(3):414-419.
20. Filler SJ, Lazarchik DA, Givan DA, Retief DH, Heaven TJ. Shear bond strengths of composite to chlorhexidine-treated enamel. Am J Dent 1994;7(2):85-88.
21. Polat O, Uysal T, Karaman AI. Effects of a chlorhexidine varnish on shear bond strength in indirect bonding. Angle Orthod 2005;75(6):1036-1040.
22. Reynolds I. A review of direct orthodontic bonding. Br J Orthodont 1975;2:171-178.
23. Yi GK, Dunn WJ, Taloumis LJ. Shear bond strength comparison between direct and indirect bonded orthodontic brackets. Am J Orthod Dentofacial Orthop 2003;124(5):577-581.

24. Pickett KL, Sadowsky PL, Jacobson A, Lacefield W. Orthodontic in vivo bond strength: comparison with in vitro results. Angle Orthod 2001;71(2):141-148.
25. Murray SD, Hobson RS. Comparison of in vivo and in vitro shear bond strength. Am J Orthod Dentofacial Orthop 2003;123(1):2-9.
26. Oltramari-Navarro PV, Titarelli JM, Marsicano JA, Henriques JF, Janson G, Lauris JR, et al. Effectiveness of 0.50% and 0.75% chlorhexidine dentifrices in orthodontic patients: a double-blind and randomized controlled trial. Am J Orthod Dentofacial Orthop 2009;136(5):651-656.
27. Bishara SE. Ceramic brackets and the need to develop national standards. Am J Orthod Dentofacial Orthop 2000;117(5): 595-597.
28. Faltermeier A, Rosentritt M, Reicheneder C, Mussig D. Experimental composite brackets: influence of filler level on the mechanical properties. Am J Orthod Dentofacial Orthop 2006;130(6):699 e699-614.
29. Sadat-Khonsari R, Moshtaghy A, Schlegel V, Kahl-Nieke B, Moller M, Bauss O. Torque deformation characteristics of plastic brackets: a comparative study. J Orofac Orthop 2004;65(1):26-33.
30. Legler LR, Retief DH, Bradley EL. Effects of phosphoric acid concentration and etch duration on enamel depth of etch: an in vitro study. Am J Orthod Dentofacial Orthop 1990;98(2):154-160.
31. Gorton J, Featherstone JD. In vivo inhibition of demineralization around orthodontic brackets. Am J Orthod Dentofacial Orthop 2003;123(1):10-14.
32. Ernst CP, Prockl K, Willershausen B. The effectiveness and side effects of 0.1 and 0.2% chlorhexidine mouthrinses: a clinical study. Quintessence Int 1998;29(7):443-448.