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A Comparison of Shear-Peel Band Strengths of 5 Orthodontic Cements

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ABSTRACT

The objective of this study was to compare the shear-peel band strength of 5 orthodontic cements using both factory and in-office micro-etched bands. The 5 orthodontic cements evaluated were a zinc phosphate (Fleck's Cement), 2 resin-modified glass ionomer cements (RMGI)(3M Multicure glass ionomer and Optiband), and 2 polyacid-modified composite resin cements (PMCR)(Transbond Plus and Ultra Band Lok). Salivary contamination was examined with a polyacid-modified composite resin (Transbond Plus). Two hundred and eighty extracted human molar teeth were embedded in resin blocks and each was randomly assigned to the following 7 groups: 6 groups with factory etched bands, 5 cement groups and salivary contaminated group, and 1 in-office micro-etched group. The cemented teeth were put in deionized water at 37°C for 30 days and thermocycled for 24 hours. The force required to break the cement bond was used as a measure of shear-peel band retention. With the use of an Instron testing machine, a shear-peel load was applied to each cemented band. Data were analyzed with a one-way analysis of variance (ANOVA) with a Tukey test for the multiple comparisons. The RMGIs and PMCRs demonstrated significantly greater shear-peel band strengths compared to the zinc phosphate cement. No statistically significant differences were noted between the RMGI cement and PMCR cements and within the RMGI groups, however, there was a statistically significant difference within the PMCR groups. Significantly lower band strengths were noted with the saliva contaminated PMCR cement group (Transbond Plus) and the in-practice sandblasted PMCR group. Both RMGIs and PMCRs were found to demonstrate favorable banding qualities. The lower band strength with saliva-contaminated bands suggests that moisture control is critical when using a PMCR. The variability noted in the in-office micro-etched bands might be technique related.

KEY WORDS: Orthodontic banding, Shear-peel band strength.

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INTRODUCTION Return to TOC

Orthodontic bands around the crowns of molars and second bicuspids still play an important role in providing stable attachment for an arch wire, and thus, their retention around the crowns is vital in the successful application of orthodontic forces leading to successful treatment.[1] A common problem experienced by many orthodontists and patients is the development of enamel demineralization and even caries following the use of brackets and bands bonded and cemented to teeth, respectively.[2–5] Previous studies have shown such demineralization more common in patients receiving bonded/banded orthodontic appliances.[2–5] Orthodontic bands are believed to facilitate more enamel demineralization than bracketed teeth.[6] Orthodontic cements have been used to enhance retention between the band and the molar, however, unfavorable properties found in many of these cements, such as high solubility in oral fluids and low bond strengths, may contribute to demineralization beneath bands.[3,4,7] External forces may lead to cement failure between band and crown and of prime concern is the shear-peel loads in an occlusal direction.

Zinc phosphate cement was introduced in 1878.[8] This cement has become the gold standard by which other cements are compared because of its long and well-documented history of clinical use in band cementation.[9–12] It provides retention primarily by mechanical adhesion between the cement and the enamel and to the stainless steel band.[13] Zinc phosphates unfavorable properties are a high solubility in the oral cavity, brittleness, and low tensile strength.[12,14] Placement of bands in the posterior part of the mouth puts them under conditions of greatest tensile and shear forces, such as in mastication or physical trauma, making them susceptible to loosening and failure.

Glass ionomer cements (GIC) were introduced in 1971 by Wilson and Kent[8] and favorable properties of these cements include low solubility in oral fluids, higher compressive and tensile strengths compared to zinc phosphate, and the ability to chelate, via an acid-base reaction, to enamel and dentin and to form ionic bonds with stainless steel.[8,12,15] In addition, it has been suggested that fluoride release from the cement to tooth enamel may occur without any loss in strength, and thus, they are of clinical benefit towards preventing enamel demineralization during orthodontic treatment.[8,16–18] GICs unfavorable properties include brittleness and susceptibility to attack by water during cement setting resulting in a weaker bond.[8,15]

A further innovation in glass ionomer technology occurred with the use of glass ionomer hybrid materials, resin-modified glass ionomers (RMGI),[19] combining properties of glass ionomers as well as the additional strength afforded by its composite resin component.[20,21] RMGIs set not only by the acid-base reaction typical of true glass ionomer cements, but also by a photochemical polymerization typical of composite resins.[22–24] A previous study by Cacciafesta et al[25] using RMGIs showed that saliva contamination actually improved shear bond strength.

A third group of cements known as polyacid-modified composite resins (PMCR) have also been developed.[23] Such cements also have the acid-decomposable glass and some polymeric acid, but in insufficient quantities to facilitate an acid-base reaction in the dark.[26] PMCRs are believed to release fluoride, albeit much less so than RMGIs, yet they have been shown to have a beneficial effect on preventing enamel demineralization.[27,28] PMCRs possess similar physical properties such as low solubility in oral fluids, high fracture resistance, and relatively higher compressive and tensile strength compared to zinc phosphate.[29,30]

Previous studies have shown that micro-etching of bands roughens the surface of the metal which increases the surface area for both chemical and mechanical bonding, thereby providing significantly greater retention than unetched bands.[31,32] In addition to roughening, sandblasting has been shown to reduce the thickness of the oxide layer, resulting in a more firmly attached layer for banding.[32] A thin oxide layer is necessary for proper wetting and bonding to metal, however, total elimination of this oxide layer results in inadequate band strengths.[32] There are 2 methods of etching bands: factory micro-etched bands and in-office sandblasted bands.

The objective of this study was to compare the shear-peel band strength of 5 orthodontic cements using factory etched bands. Comparison with in-office micro-etched bands and saliva contamination was also examined with a PMCR (Transbond Plus).

MATERIALS AND METHODS Return to TOC

Band cementation

Two hundred and eighty extracted human molars without caries were collected from the office of a local oral surgery clinic and cleaned of large debris. Although the teeth were received in 10% formalin, they were promptly rinsed and stored in deionized water and polished with fluoride-free dental prophylactic paste (Zircate Prophy Paste, LD Caulk) to remove any fine debris. The teeth were randomly divided into 7 equal groups according to the following materials:

Group 1: Zinc Phosphate cement (Fleck's Cement, Mizzy Inc, Cherry Hill, New Jersey);

Group 2: 3M Multicure Glass Ionomer cement (3M Unitek Dental Products, Monrovia, Calif): a resin-modified glass ionomer;

Group 3: Optiband cement (Ormco Co, Orange, Calif): a resin-modified glass ionomer;

Group 4: Ultra Band Lok cement (Reliance Orthodontic Products Inc, Itasca, Ill): a polyacid-modified composite resin;

Group 5: Transbond Plus cement–Dry (3M Unitek Dental Products, Monrovia, Calif): a polyacid-modified composite resin;

Group 6: Transbond Plus cement–Saliva Contaminated (3M);

Group 7: Transbond Plus cement–In-practice sandblasted (3M).

Each group received equal numbers of maxillary and mandibular molars. Stainless steel orthodontic bands (3M Unitek Victory Series, Monrovia, Calif) with no attachments were fitted and seated around the teeth including adaptation of the margins with a band seater. Bands were selected and placed by the same operator to eliminate any operator bias in band positioning and fitting. Group 6 was contaminated by brushing a small layer of human saliva onto the crown prior to band cementation. Sandblasting for Group 7 was performed with a micro-etcher (Danville Engineering Inc, San Ramon, Calif) with a stream of aluminum oxide (50 µm) particles under 80 psi of air pressure was sprayed for 15 seconds against the luting surface of the metal band until a uniform frosty appearance on the metal was achieved. In-office sandblasting was completed immediately prior to band cementation to simulate clinical practice.

A hole was drilled through the center of each tooth near the root furcation area and a .033 SSW 5 cm long was placed in the hole to resist pulling of the tooth out of the embedding medium at debanding. Each band was cemented in place according to the manufacturers' instructions. All light curable cements were cured with a visible light-curing unit for 40 seconds. Care was taken to ensure that all excess cement was removed from the occlusal and cervical margins of the band to prevent excess cement from influencing the results.

The cementing agents were allowed to bench set for 2 minutes and then the teeth were placed into 7 sealable plastic containers, according to group, containing deionized water. The containers were then incubated for 30 days at 37°C. The purpose of incubation in deionized water is to simulate cement dissolution as can occur naturally in the oral cavity by saliva. Following the incubation period, all specimens were thermocycled for 24 hours in 2 thermally control water units at 10°C and 50°C for 24 hours (30 seconds at 10°C and 30 seconds for 1440 cycles). The teeth were then placed in plastic ice cube trays and filled with epoxy resin approximating the height of normal bone (6 cm × 3.5 cm × 3 cm). The resin was allowed to set leaving only the crown of each tooth exposed with several millimeters between the band and the resin.

Band removal

Each mounted tooth was clamped to a customized holding device fixed to the lower load cell of the Instron machine (Figure 1). The holding device contained a hole in its top component allowing the crown of each tooth to protrude through and be directly below the loop attachment of the pressure transducer of the Instron machine (Figures 2 and 3). This configuration allowed all forces to be directed parallel to the long axis of the tooth during debanding. The loop was attached to a customized band removal device (a gold foil separator modified to function as a band remover instrument) to simulate clinical shear-peel loads. The band removal device was attached to mandibular teeth from the midbuccal side and to maxillary teeth from the midpalatal side to simulate a band remover instrument and to standardize the band removal technique for all specimens. There was little risk of band dislodgement with the band removal instrument. One operator performed all debanding to eliminate any bias in band removal.

Calculation of shear-peel band strength

Using the Instron machine in tensile mode with a crosshead speed of 0.5 mm/min and a Phillips XT recorder, the force (kg) required to initially fracture the cement bond was used as a measure of cement band retention. Multiplying by a conversion factor of 9.81 resulted in a force in Newtons (N). The band was cleaned with a sickle scaler and pumice, cut with crown and bridge scissors, and laid out flat such that its length and width were measured to the nearest 10th of a millimeter with millimeter calipers, and thus, its area was determined in mm^2. Dividing the debanding force (N) by the band area (mm^2) resulted in the shear-peel band strength expressed in megapascals (MPa).

Statistical analysis

Descriptive statistics, means, and standard deviations were calculated for the shear-peel band strength data for each adhesive group. A one-way analysis of variance (ANOVA) was performed to test for statistical significance. A Tukey test was used to determine the statistical significance between the groups.

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The mean shear-peel band strengths (SPBS) ranged from 3.383 (± 0.426) to 6.420 (± 0.631) MPa, which represents a difference of 3.037 MPa (Table 1, Figure 4). The order of mean SPBS from greatest to least is as follows: Transbond Plus–dry > 3M Multicure Glass Ionomer ≅ Optiband > Ultra Band Lok > Zinc phosphate > Transbond Plus–saliva contaminated > Transbond Plus–sandblasted.

An ANOVA with multiple comparisons (Post Hoc Tukey test) showed that the shear bond strengths of the 5 materials determined 30 days after initial cementation differed (Table 2). The mean shear-peel band strength of 3M Multicure Glass Ionomer closely approximated those of Optiband, Ultra Band Lok, and Transbond Plus–dry. 3M Multicure Glass Ionomer, Ultra Band Lok, and Optiband had statistically significant greater mean SPBS compared to Zinc phosphate, Transbond Plus–saliva contaminated, and Transbond Plus–sand-etched ($P < .05$). The mean SPBS of Zinc phosphate cement was significantly greater than those of Transbond Plus–saliva contaminated and Transbond Plus–sandetched. Transbond Plus–dry showed a statistically significant greater mean SPBS than Ultra Band Lok, Zinc phosphate, and Transbond Plus–saliva contaminated which was in turn significantly greater than Transbond Plus–sandblasted. The mean SPBS of all factory micro-etched band groups (1–6) were significantly higher than the sandblasted band group (7).

DISCUSSION Return to TOC

Band strength

A comparison of the mean shear force required to remove orthodontic bands showed that both resin-modified glass ionomer cements (RMGI) and both polyacid-modified composite resin cements (PMCR) significantly stronger than zinc phosphate cement ($P < .05$). Both RMGI and PMCR have the ability to chemically bond with both enamel and stainless steel metal, whereas zinc phosphate does not chemically bond with either substance, only mechanically. The ability of RMGIs and PMCRs to possibly form ionic bonds with metal and to chelate enamel may allow these cements to resist debanding more significantly than zinc phosphate, which binds only mechanically. There may also be a greater tendency for zinc phosphate to dissolve in fluids and/or to weaken under thermal stress than RMGI or PMCR which also helps to explain the greater resistance of these latter cements to debanding.

Between the resin-modified glass ionomer cements and the polyacid-modified composite resin cements, there was no significant difference in shear-peel band strengths (SPBS)($P > .05$). Although Transbond Plus–Dry PMCR showed slightly greater SPBS than both 3M Multicure Glass Ionomer and Optiband, both these RMGIs in turn showed slightly greater shear-peel band strengths than Ultra Band Lok PMCR. Furthermore, the findings indicate that both the RMGIs and the PMCRs were affected by water/saliva solubilization and thermocycle stresses to similar extents. Within the resin-modified glass ionomer group, a comparison of mean shear-peel force showed that not only do 3M Multicure Glass Ionomer (6.289 MPa) and Optiband (6.286 MPa) possess mean shear bond strengths that are not significantly different, but also they were nearly equal ($P > .05$). The findings in this study suggest that both RMGI cements resisted water/saliva dissolution and thermal stresses equally, and therefore, both types of RMGIs would perform in a similar fashion clinically.

Although for the polyacid-modified composite resin group Transbond Plus–Dry (6.420 MPa) showed a greater shear-peel band strength than Ultra Band Lok (5.924 MPa)($P < .05$), this difference of only 0.5 MPa may not be clinically relevant. Since both cements consist of a single-paste system that is visible light-cured, the difference in SPBS may be explained by a slightly greater tendency for Ultra Band Lok PMCR to dissolve or weaken in water under thermocycle stresses than Transbond Plus–Dry. Investigation into the differences in resin composition between the 2 PMCRs may help to explain this formation of weaker chemical bonds with Ultra Band Lok.

Saliva contamination

Information regarding the necessity to maintain a dry working field during cementation of molar bands with a PMCR is limited. Contamination with human saliva prior to cementation of bands with Transbond Plus PMCR (4.557 MPa) resulted in a significantly lower shear-peel band strength compared to bands cemented with Transbond Plus on dry crowns (6.420 MPa) ($P < .05$), which indicated that PMCRs behave most like composite resins, which require a dry field as an important clinical step. RMGIs, on the other hand, behave more like glass ionomers, and thus, their adhesion was enhanced by salivary moisture which properly wets the enamel surface. The findings suggest that salivary water interfered with the chemical bonds that form between the cement and enamel, thereby weakening the bond between band and tooth. However, the bond between cement and metal was still stable in the saliva contaminated specimens, and thus, all bonds were broken at the cement-enamel interface. This aspect of the study suggests the necessity for a dry working field when using PMCRs.

Micro-etching

The comparison between 2 different methods for micro-etching bands using Transbond Plus yielded a significantly greater shear-peel band strength with factory etching (6.420 MPa) relative to in-practice sandblasting (3.383 MPa), which represented almost a 2-fold difference in SPBS between the 2 test groups. The factory micro-etching technique, which resulted in a greater degree of surface roughness, provided a stronger bond between metal band and cement, and thus, between band and tooth. In this study, the significantly greater SPBS of factory-etched bands implies that such a technique leads to greater metal roughness, and thus, superior band retention over the sandblasting technique. Scanning electron photographs (SEM)(10 KV, 1000× magnification) of the luting surface of 1 factory etched band (Figure 5) and 1 in-practice sandblasted band (Figure 6) lend qualitative evidence to support this claim, although further studies with quantitative measurements of such photographs would be useful.

Although most of the experimental protocol in this study was similar to that of previous studies, our numerical findings cannot be easily compared with those of previous studies for several reasons.[12,20,21,23,30,33] First, while previous studies used an Instron band removal device that hooked onto band attachments from both buccal and lingual sides of the band, we utilized a band removal device similar to a band removal hand instrument to more accurately simulate shear-peel forces that occur clinically. The intent of this experiment was to examine new orthodontic luting cements such as RMGIs and PMCRs for improved handling characteristics and potential fluoride release. Comparisons with previous studies was difficult because different cements were used. The occurrence of statistically significant differences in shear-peel band strengths between RMGIs, PMCRs, and zinc phosphate lends evidence to the possibility of improvement over traditional banding cements.

A previous experiment by Wood and Paleczny[32] utilized the same teeth and bands with multiple cements with the purported idea of minimizing variability during statistical analysis. However, this study used different teeth and bands for each group for the purpose of avoiding the deformation that occurs during debanding that would, after repeated cementation and debanding, result in progressively weaker shear bond strengths with each cement used. Furthermore, Wood and Paleczny removed bands from both buccal and lingual simultaneously and did not use thermocycling or long-term storage in moisture to simulate factors that influence band retention in a patient's oral cavity. The use of clinically proper technique in band removal (buccal of mandibular, palatal of maxillary) coupled with the use of such influencing factors in this study would lead one to expect significantly lower SPBS in Transbond Plus–sandblasted bands (3.383 MPa) compared with Wood and Paleczny's tensile-loaded sandblasted bands (range 1.94–2.43 Mpa). However, regardless of the influence of thermocycling and long-term storage in moisture, Transbond Plus still forms a stronger bond between band and tooth compared to zinc phosphate when using sandblasted bands. Despite these differences from previous studies, use of the larger sample sizes and the occurrence of acceptably low standard errors lends credibility of this protocol for testing shear-peel band strengths of orthodontic bands, amongst other protocols.

Although this study showed statistically greater shear-peel band strengths of RMGIs and PMCRs compared with zinc phosphate, the question of whether these small numerical differences are clinically significant can be answered by proposing that RMGIs and PMCRs are at least as effective, if not better, than zinc phosphate cement in retaining orthodontic bands. Further research into the amount of fluoride released from RMGI and PMCR cements and cariopreventative activity in the short-term and long-term would lead to further data on the ability of these cements to prevent enamel demineralization under acid attack, and thus, offer possible replacements for zinc phosphate cement.

CONCLUSIONS Return to TOC

Resin-modified glass ionomer cements (RMGI) and polyacid-modified composite resin cements (PMCR) required significantly higher forces to deband in comparison with zinc phosphate cement. The RMGIs and PMCRs showed little difference in shear-peel band strength in relation to each other. 3M Multicure Glass Ionomer (RMGI) displayed little difference in shear-peel band strength when compared to Optiband glass ionomer (RMGI). Transbond Plus required significantly higher shear forces to deband compared to Ultra Band Lok PMCR. Saliva contamination of molar crowns prior to band cementation with the PMCR Transbond Plus led to significantly less shear force needed to remove the band as opposed to crowns banded in a dry working field. Factory micro-etching of the luting surface of stainless steel bands provide almost double the band retention compared with sandblasting of bands, when using PMCR as the bonding agent.

REFERENCES Return to TOC

1. Gottlieb EL, Nelson AH. Vogels DS 3d. 1986 JCO study of orthodontic diagnosis and treatment procedures. *J Clin Orthod.* 1986; 20:612–625.

2. Ogaard B. Prevalence of white spot lesions in 19-year olds: a study on untreated and orthodontically treated persons 5 years after treatment. *Am J Orthod Dentofacial Orthop.* 1989; 96:423–427. [PubMed Citation]

3. Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. *Am J Orthod.* 1982; 81:93–98. [PubMed Citation]

4. Mizrahi E. Surface distribution of enamel opacities following orthodontic treatment. *Am J Orthod.* 1983; 84:323–331. [PubMed Citation]

5. Artun J, Brobakken BO. Prevalence of carious white spots after orthodontic treatment with multibonded appliances. *Eur J Orthod.* 1986; 8:229–234. [PubMed Citation]

6. Ogaard B, Rolla G, Arends J. Orthodontic appliances and enamel demineralization. Part I. Lesion development. *Am J Orthod Dentofacial Orthop.* 1988; 94:68–73. [PubMed Citation]

7. Sadowsky PL, Retief DH. A comparative study of some dental cements used in orthodontics. *Angle Orthod.* 1976; 46:171–181. [PubMed Citation]

8. Norris DS, McInnes-Ledoux P, Schwanninger B, Weinberg R. Retention of orthodontic bands with new fluoride-releasing cements. *Am J Orthod.* 1986; 89:206–211. [PubMed Citation]

9. Dennison JD, Powers JM. A review of dental cements used for permanent retention of restorations. Part I. Composition and manipulation. *J Mich State Dent Assoc.* 1974; 56:116–121. [PubMed Citation]

10. Craig RG, O'Brien WJ, Powers JM. *Dental Materials.*. 2d ed. London: Mosby. 1979;104–106.

11. Wei SH, Sierk DL. Fluoride uptake by enamel from zinc phosphate cement containing stannous fluoride. *J Am Dent Assoc.* 1971; 83:621–624. [PubMed Citation]

12. Maijer R, Smith DC. A comparison between zinc phosphate and glass ionomer cement in orthodontics. *Am J Orthod Dentofacial Orthop.* 1988; 93:273–279. [PubMed Citation]

13. Grieve AR, Jones JC. Marginal leakage associated with four inlay cementing materials. An in vitro comparison. *Br Dent J.* 1981; 151:331–334. [PubMed Citation]

14. Smith DC. A review of the zinc polycarboxylat cements. *J Can Dent Assoc.* 1971; 37:22–29. [PubMed Citation]

15. Phillips RW. *Skinner's Science of Dental Materials.* . 8th ed. Philadelphia, Penn: WB Saunders. 1982;452–479.

16. Hamula W, Hamula D, Brower K. Glass ionomer update. *J Clin Orthod.* 1993; 27:420–425. [PubMed Citation]

17. White LW. Glass ionomer cement. *J Clin Orthod.* 1986; 20:387–391.

18. Crisp S, Lewis BG, Wilson AD. Glass ionomer cements: chemistry of erosion. *J Dent Res.* 1976; 55:1032–1041. [PubMed Citation]

19. McLean JW, Nicholson JW, Wilson AD. Proposed nomenclature for glass-ionomer dental cements and related materials. *Quintessence Int.* 1994; 25:587–589. [PubMed Citation]

20. Millett DT, Kamahli K, McColl J. Comparative laboratory investigation of dual-cured vs conventional glass ionomer cements for band cementation. *Angle Orthod.* 1998; 68:345–350. [PubMed Citation]

21. Ashcraft DB, Staley RN, Jakobsen JR. Fluoride release and shear bond strengths of three light-cured glass ionomer cements. *Am J Orthod Dentofacial Orthop.* 1997; 111:260–265. [PubMed Citation]

22. Sidhu SK, Watson TF. Resin-modified glass ionomer materials: a status report for the American Journal of Dentistry. *Am J Dent.* 1995; 8:59–66. [PubMed Citation]

23. Millett DT, Gordon PH. The performance of first molar orthodontic bands cemented with glass ionomer cement—a retrospective analysis. *Br J Orthod.* 1992; 19:215–220. [PubMed Citation]

24. Craig RG. *Restorative Dental Materials.* . 8th ed. St Louis, Mo: Mosby. 1989;195

25. Cacciafesta V, Jost-Brinkmann PG, Subenberger U, Miethke RR. Effects of saliva and water contamination on the enamel shear bond strength of a light-cured glass ionomer cement. *Am J Orthod Dentofacial Orthop.* 1998; 113:402–407. [PubMed Citation]

26. Brown D. Orthodontic materials update: orthodontic band cements. *Br J Orthod.* 1989; 16:127–131. [PubMed Citation]

27. Suljak JP, Hatibovic-Kofman S. A fluoride release-adsorption-release system applied to fluoride-releasing restorative materials. *Quintessence Int.* 1996; 27:635–638. [PubMed Citation]

28. Chung CK, Millett DT, Creanor SL, Gilmour WH, Foye RH. Fluoride release and cariostatic ability of a compomer and a resin-modified glass ionomer cement used for orthodontic bonding. *J Dent.* 1998; 26:533–538. [PubMed Citation]

29. Attin T, Vataschkil M, Hellwig E. Properties of resin-modified glass ionomer restorative materials and two polyacid-modified resin composite materials. *Quintessence Int.* 1996; 27:203–211. [PubMed Citation]

30. Gladys S, Van Meerbeek B, Braem M, Lambrechts P, Vanherle G. Comparative physico-mechanical characterization of new hybrid restorative materials with conventional glass-ionomer and resin composite restorative materials. *J Dent Res.* 1997; 76:883–894. [PubMed Citation]

31. Millett DT, McCabe JF, Bennett TG, Carter NE, Gordon PH. The effect of sandblasting on the retention of first molar orthodontic bands cemented with glass ionomer cement. *Br J Orthod.* 1995; 22:161–169. [PubMed Citation]

32. Wood DP, Paleczny GJ, Johnson LN. The effect of sandblasting on the retention of orthodontic bands. *Angle Orthod.* 1996; 66:207–214.

33. Kocadereli I, Ciger S. Retention of orthodontic bands with three different cements. *J Clin Pediatr Dent.* 1995; 19:127–130. [PubMed Citation]

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TABLE 1. Mean Shear-Peel Band Strengths for Zinc Phosphate Cement, 2 Resin-Modified Glass Ionomer Cements, and 2 Poly-Acid Modified Composite Resin Cements

	N 280	Mean Shear-Peel Band Strength (MPa)	Standard Deviation (MPa)	Min (MPa)	Max (MPa)
Transbond Plus–Dry	40	6.4	0.7	6.2	6.6
3M Multiculture Glass Ionomer	40	6.3	0.7	6.1	6.5
Optiband	40	6.3	0.7	6.1	6.5
Ultra Band Lok	40	5.9	0.8	5.7	6.2
Zinc Phosphate	40	5.4	0.6	5.2	5.6
Transbond Plus–Saliva Contaminated	40	4.6	0.6	4.4	4.7
Transbond Plus–Sandblasted	40	3.4	0.4	3.2	3.5

N indicates number of patients; min, minimum; max, maximum; and MPa, megapascals.

TABLE 2. Statistical Significance of the Shear-Peel Band Strengths of Homogenous Cements

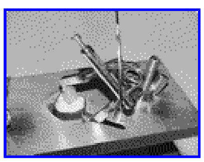
	Transbond Plus–Dry	3M Multicure Glass Ionomer	Optiband	Ultra Band Lok	Zinc Phos-phate	Transbond Plus–Saliva Con-tamin.	Transbond Plus–Sandblasted
Transbond Plus–Dry	X	—	—	*	*	*	*
3M Multiculture Glass Ionomer	—	X	—	—	*	*	*
Optiband	—	—	X	—	*	*	*
Ultra Band Lok	*	—	—	X	*	*	*
Zinc Phosphate	*	*	*	*	X	*	*
Transbond Plus–Saliva Contamin.	*	*	*	*	*	X	*
Transbond Plus–Sandblasted	*	*	*	*	*	*	X

— indicates $P > .05$; *, $P < .05$; noncomparable entries are designated by X.

FIGURES Return to TOC

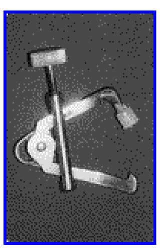
Click on thumbnail for full-sized image.

FIGURE 1. Mounted tooth clamped to a customized holding device fixed to the lower load cell of the Instrom machine



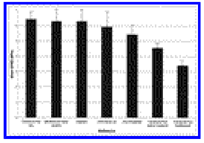
Click on thumbnail for full-sized image.

FIGURE 2. Device used to fix hold mounted tooth during band removal



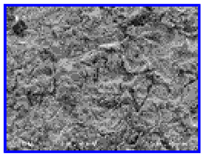
Click on thumbnail for full-sized image.

FIGURE 3. Customized band removal device used to simulate clinical shear-peel load



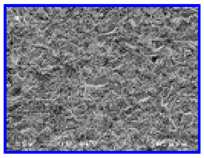
Click on thumbnail for full-sized image.

FIGURE 4. Mean shear-peel band strengths of 5 orthodontic cements, one saliva-contaminated PMCR cement and one in-office micro-etched band PMCR cement



Click on thumbnail for full-sized image.

FIGURE 5. Scanning electron micrograph of a factory chemically micro-etched orthodontic band



Click on thumbnail for full-sized image.

FIGURE 6. Scanning electron micrograph of an in-office sandblast micro-etched orthodontic band

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