ORIGINAL ARTICLE

Effects of surface treatment and aging on the bond strength of orthodontic brackets to provisional materials

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Purpose: The aim of this study was to evaluate the effects of different surface treatments and aging on the bond strength of orthodontic brackets bonded to provisional materials (autopolymerizing polymethylmethacrylate [PMMA] resins and bis-acryl composite). The mode of failure was also compared. **Material:** One hundred twenty flat-surfaced disks of each provisional material were fabricated and embedded in acrylic molds. The specimens were divided randomly into 3 groups of 40, according to the surface treatment rendered: control, polished with greenstone, and sandblasted. Brackets were bonded, and specimens were stored in water at 35°C. Half the specimens in each group were debonded after 1 week, and the other half were debonded after 1 month with a shear-peel load on a testing system with a crosshead speed of 0.5 mm/min. The amount of composite resin left on the specimen surfaces was analyzed and classified with the adhesive remnant index. **Results:** The bond strengths of brackets to bis-acryl composite resin for all 3 surfaces were clinically acceptable (9-12 MPa) when compared with PMMA (3-5 MPa). The bond strengths of both provisional materials were generally influenced by the kind of surface treatment and aging. The mode of failure was adhesive for PMMA and predominantly cohesive for bis-acryl composite provisional materials. **Conclusions:** The bond strength of orthodontic brackets to provisional restorations might depend on material, surface treatment, and time. Brackets should be bonded to bis-acryl composite provisional restorations within 1 week of fabrication. (Am J Orthod Dentofacial Orthop 2007;132:577.e7-577.e11)

Orthodontists frequently find themselves needing to bond brackets onto temporary crowns made from provisional material for adjunctive[1] or comprehensive orthodontic treatment. Traditionally, provisional restorations are made from autopolymerizing polymethylmethacrylate (PMMA) resins. PMMA resins are prone to discoloration, and, because of their exothermic nature, they can cause chemical irritation or allergic reactions during polymerization.[2] Recently, composite resins have gained popularity because of their ease of manipulation, reported low polymerization shrinkage, and lack of exothermic reaction.[3,4] Bis-acryl composite resins have been shown to be statistically superior to PMMA resins in contour and marginal adaptation.[5] Their better marginal adaptation reduces the chance of gingival inflammation. Very few studies have been conducted on the bond strength of orthodontic brackets to provisional restorative materials. As awareness of dental esthetics increases, more patients are seeking orthodontic treatment as an adjunct to their dental treatment. Therefore, the incidence of bonding brackets onto provisional restorations is expected to increase. The aim of this study was thus to evaluate the effects of surface treatment and aging on the bond strength of orthodontic brackets to 2 provisional materials, PMMA and bis-acryl composite resins.

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MATERIAL AND METHODS

Provisional materials evaluated were chemically cured PMMA (Temporary Bridge Resin [TBR]; Dentsply Caulk, Milford, Del) and bis-acryl composite resin (Protemp 3 Garant [P3G]; 3M ESPE, Seefeld, Germany). These material specimens were produced and divided into various groups according to the surface treatment received and interval before debonding (Table I).

One hundred twenty specimens of each provisional material were fabricated. A slurry of each material was prepared according to the manufacturer's recommended powder/liquid ratio and placed into the recesses (7-mm diameter by 2-mm height) of customized

Table I. Number of specimens according to materials, surface treatments rendered, and duration before debonding

		Surface treatment		
Material	*Duration*	*Glass (control)*	*Greenstone*	*Sandblast*
TBR	1 wk	20	20	20
	1 mo	20	20	20
P3G	1 wk	20	20	20
	1 mo	20	20	20

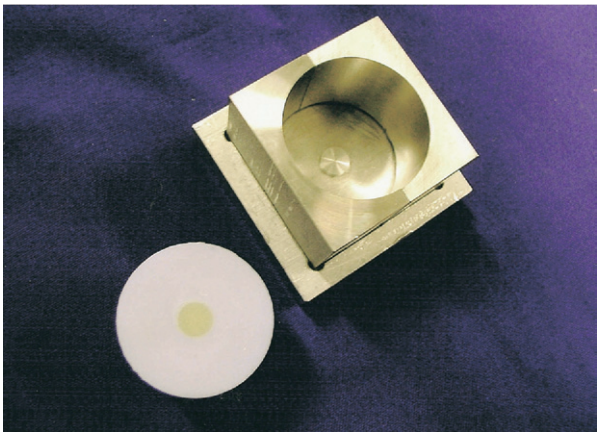

Fig 1. Customized acrylic mold with metal jig.

acrylic molds (Fig 1). A glass slide was placed over the molds, and pressure was applied to extrude excess material. Both materials were left to set at room temperature for 10 minutes and then randomly divided into 2 groups and stored in distilled water at 35°C. Specimens in group 1 were tested after 1 week of storage in distilled water; specimens in group 2 were tested after 1 month of storage.

After the 2 storage periods, the specimens were pumiced for 10 seconds, air dried, and randomly divided into the following treatment groups: (1) no treatment (control), (2) polished with greenstone, and (3) sandblasted. Treatment with greenstone was done with a slow-speed handpiece rotating at 2000 rpm for 10 seconds. The sandblasted group was treated with the Microetcher Intraoral Sandblaster (Danville Engineering, San Ramos, Calif) with 50-μm grains for 10 seconds. All specimens were subsequently surface treated with 37% phosphoric acid (3M Unitek, Monrovia, Calif) for 30 seconds, rinsed, and air dried. A thin layer of unfilled resin primer (3M Unitek) was then applied.

Stainless steel maxillary central incisor brackets (256-Begg Bracket Flat Base; T.P. Orthodontics, LaPorte, Ind) with flat bases (3.3 × 3.3 mm) were then bonded onto the surface of the specimens with light-cured composite adhesive (Transbond XT; 3M Unitek). Bonding was done by 1 operator (N.M.). A custom-designed jig was used to apply a constant vertical force of 5 N on the bracket for 10 seconds (Fig 2) to ensure that consistent force was applied to seat the brackets and obtain uniform thickness of the adhesive layer. Excess adhesive around the bracket base was removed. The bonded specimens were stored again in distilled water at 35°C.

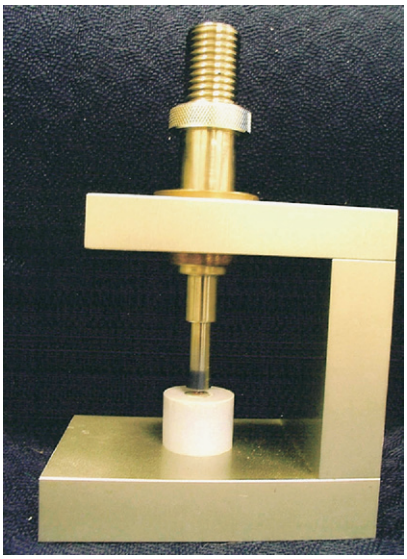

Fig 2. Customized metal jig to provide standardized force to bond bracket.

The shear-peel bond test in the first group was carried out 1 week after surface treatment and bonding of the brackets. The samples were first inserted into a custom-made shear test jig (Instron, Canton, Mass) and then debonded with a shear-peel load with a uniaxial testing system (Instron Calibration Laboratory 4302) with a crosshead speed of 0.5 mm/min. Each sample was secured in a bench vice with the base of the bracket positioned parallel to the plunger of the testing machine. This was to minimize variation in the direction of the debonding force.[6] Shear-peel bond strength (in megapascals) was determined by dividing the shear force values (in Newtons) by the nominal bracket base area (in mm^2).

After debonding, the specimens were examined under a stereomicroscope at 20× magnification to assess the adhesive remnants on the specimen surfaces. The adhesive remnant index (ARI) by Årtun and Bergland[7] was used for this assessment. The ARI was scored 0 to 3, as follows: 0 = no adhesive left