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Research

Repeated bracket bonding: Conventional or self-etching primer?

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ABSTRACT

Background: The aim of this study was to evaluate the effects of repeated bonding using a conventional primer (CP) or a self-etching primer (SEP) on the in vitro shear bond strength (SBS) and adhesive remnant index (ARI) of orthodontic brackets.
Methods: A total of 144 human premolars were divided into two equal-sized groups and bonded with metal brackets using a CP in one group and an SEP in the other group. The SBS and ARI were determined after bracket debonding using a universal testing machine. Each group of premolars was then further divided into two equal-sized subgroups, which were bonded with new brackets using a CP in one subgroup and an SEP in the other subgroup. Again, the SBS and ARI were determined. Differences in SBS and ARI between the groups and among the subgroups were tested for statistical significance.
Results: During the first debonding sequence, the mean SBS values were 10.60 and 10.13 MPa in the CP and SEP groups, respectively. During the second debonding sequence, the mean SBS values ranged from 10.37 to 11.39 MPa. Most or all adhesive remained on the tooth after bracket debonding. There were no statistically significant differences in SBS or ARI between the first and second debonding sequences, between the groups, or among the subgroups.
Conclusion: With regard to SBS and ARI, SEPs perform as well as CPs for repeated bracket bonding.

1. Introduction

Bracket failure or inaccurate placement may necessitate repeated bracket bonding during orthodontic treatment. Reported bracket failure rates range from 6% to 20% [1,2], and most clinicians prefer repositioning incorrectly placed brackets over placing compensating bends in the archwire [3,4]. For these reasons, a significant number of teeth are being rebonded in busy orthodontic practices.

For fixed appliance therapy to be successful, the brackets must have adequate bond strength. However, the bond strength also needs to be low enough that the appliances can be removed without enamel damage. Therefore, knowledge of the bond strength of brackets bonded to enamel surfaces from which bonded attachments have become dislodged is necessary. Although this rebond strength has been reported to be high enough to keep the brackets on the teeth for the duration of treatment [5,6], the literature provides inconsistent findings as to how it compares with original bond strength. Some authors have reported that rebond strength is lower [7,8], whereas others have reported that it is comparable to that of the original bond [5,6].

In addition to bond strength, bond failure type is a factor of clinical importance. When a strong bond has been achieved, bond failure at the enamel surface is undesirable because the adhesive may tear the enamel surface as it is pulled away from it. Therefore, fracture within the adhesive or at the adhesive–bracket interface are the failure types preferred by most orthodontists, and it is considered ideal if the adhesive remains on the tooth surface after debonding [4,9].

Although the conventional acid-etch technique and conventional primers (CPs) are still considered the clinical standard for bonding brackets to teeth, the use of self-etching primers (SEPs) has increased as a result of their quick and simplified technique. At present, etching and priming of the tooth surface are often done in a single step, especially when brackets are rebonded. Although various studies corroborate the efficacy of SEPs as a successful alternative to CPs for initial bracket bonding [10–12], research into the use of these materials for rebonding is scarce, and questions remain regarding the resulting bond strength and bond failure type when they are used for repeated bracket bonding. Therefore, the aim of this study was to investigate the

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effect of repeated bonding using a CP and an SEP on the shear bond strength (SBS) and adhesive remnant index (ARI) of orthodontic brackets in vitro.

2. Materials and methods

2.1. Specimen preparation

Approval to conduct this study was obtained from the institutional review board at the University of Minnesota. A total of 144 human premolars extracted for orthodontic reasons were collected, washed in running water, and stored in a 0.1% aqueous solution of thymol at room temperature [13]. Selection criteria included sound noncarious buccal enamel, a nonfrosty natural surface gloss, and no pretreatment with chemical agents such as hydrogen peroxide. The teeth were freed from remnants of the periodontal ligament, randomly divided into two equal-sized groups, and mounted in orthodontic acrylic resin (Dentsply Caulk; Dentsply International, Milford, DE) in sets of six teeth each. The teeth were embedded in acrylic to just below the cementoenamel junction, with the buccal tooth surface perpendicular to the acrylic base. Each buccal tooth surface was polished using a fluoride-free prophylaxis paste (Topex Prep & Polish; Sultan Healthcare, Hackensack, NJ) on a rubber cup attached to a low-speed handpiece for 5 seconds, rinsed with water, and air-dried.

The buccal enamel was primed using a CP (Transbond XT Primer, 3M Unitek, Monrovia, CA) in group 1 and an SEP (Transbond Plus Self Etching Primer; 3M Unitek) in group 2, following the manufacturer's instructions for each primer (Fig. 1). In brief, the buccal enamel of the teeth in group 1 was etched with 35% phosphoric acid (Temrex Corp., Freeport, NY) for 30 seconds, rinsed with water for 30 seconds to ensure complete removal of the etchant, and then air-dried until it appeared dull and frosty. A uniform coat of CP was applied to the etched enamel and dried into a thin film with a gentle air burst delivered for 1 to 2 seconds perpendicular to the buccal surface of each tooth. The buccal enamel of the teeth in group 2 was rubbed with the SEP for 5 seconds per tooth. The applicator was re-dipped into the primer before it was rubbed onto the next tooth. A gentle air burst was delivered for 1 to 2 seconds perpendicular to the buccal surface of each tooth to evaporate solvents. Metal premolar brackets (Victory Series Bracket System, 3M Unitek) were then bonded with a bisphenol glycidyl dimethacrylate composite adhesive (Transbond XT Light Cure Adhesive, 3M Unitek) under a constant pressure of 3 N, which was calibrated with a pressure gauge (Correx, Haag-Streit AG, Bern, Switzerland). Excessive adhesive was removed with a sharp scaler. The adhesive was then light-cured for 20 seconds with a light-emitting diode polymerization device (Ortholux LED, 3M Unitek). The distance between the exit window and the adhesive surface was maintained at <5 mm to obtain optimum polymerization. The order of bonding was randomized by arbitrarily selecting a set of six teeth, bonding this set following the assigned protocol, and then randomly selecting the next set of six teeth. After completion of the bonding procedure, the specimens were stored in distilled water at 37°C for 24 hours to allow for bond maturation, as suggested elsewhere [14].

2.2. Shear bond strength and adhesive remnant index

The SBS was determined using a universal testing machine (Instron 4204, static load cell 5 kN; Instron, Norwood, MA). A steel rod with a chisel-shaped end was attached to the crosshead for the application of an occlusal-gingival load to the bracket, producing a shear force at the bracket–tooth interface (Fig. 2). The crosshead was moved downward at a speed of 1 mm/min, and the brackets were loaded until fracture. The SBS was calculated using the required debonding force and the measured bracket base surface area of 10.40 mm^2.

Once the brackets were debonded, the ARI [15] was scored under $\times 10$ magnification using an optical microscope (MVX10, Olympus Corp., Tokyo, Japan), as follows: 0 = all adhesive left on the bracket base; 1 = more than half of the adhesive left on the bracket base; 2 = less than half of the adhesive left on the bracket base; and 3 = no adhesive left on the bracket base.

Adhesive remnants were removed from the tooth surfaces using a tungsten carbide finishing bur (model H 283-21-012, Brasseler USA, Savannah, GA) in a low-speed handpiece. Adhesive removal was considered complete when the tooth surface felt smooth and appeared free of composite to the naked eye under a dental operating light. Each group of teeth was then further divided into two equal-sized subgroups, bonded with new brackets using a CP in one subgroup and an SEP in the other subgroup, as described for the initial bonding procedure, and the SBS and ARI were determined as detailed previously (Fig. 1). All procedures were performed by a single operator.

2.3. Statistical analysis

Mean values, standard deviations, and coefficients of variation of SBS were calculated for each group and subgroup. Differences in SBS between the groups and among the subgroups were tested for statistical significance using a Mann-Whitney *U* test and Kruskal-Wallis one-way ANOVA by ranks, respectively, after the data had

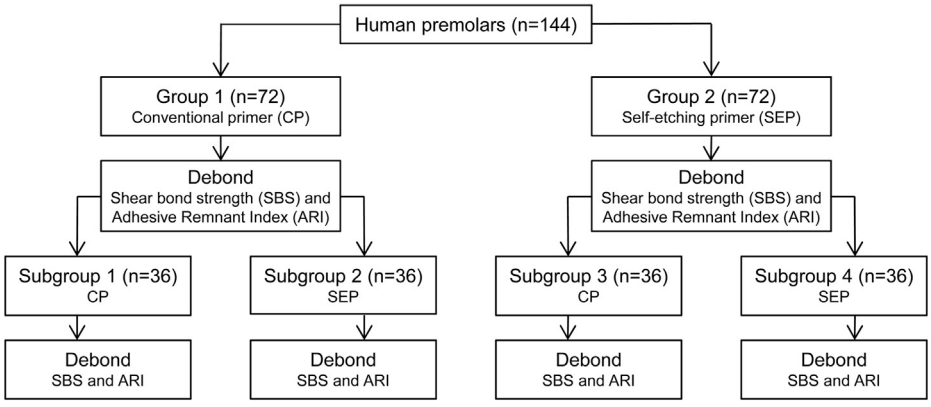

Fig. 1. Study design.