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Research

The effect of orthodontic adhesive and bracket-base design in adhesive remnant index on enamel

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ABSTRACT

Background: The purpose of this study was to identify the effects of bracket-base design and adhesive on adhesive remnant index (ARI) and enamel surface area covered by adhesive.
Methods: The sample consisted of 32 recently extracted premolars. The teeth were randomly assigned to one of four groups: conventional mesh base and composite resin; laser-etched base and composite resin; conventional mesh base and resin-modified glass ionomer; and laser-etched base and resin-modified glass ionomer. After a week, all brackets were debonded. The debonded bracket-base surface and the buccal surface of each tooth were studied under the microscope, and the remaining adhesive was scored using the ARI. The extent of coverage of the tooth by adhesive remnants was also calculated, outlining the different areas of adhesive.
Results: A Fisher's exact test indicated significant differences between the groups. The adhesive resin group showed the highest ARI scores independent of the bracket-base design, whereas between the two bracket-base designs, the laser-etched bracket design showed higher ARI. ARI scores reliably depict the extent of enamel covered by adhesive compared with the measurement of the actual area covered.
Conclusion: Varying the bracket base and adhesive may result in different ARI scores, which can affect the enamel surface during debonding.

1. Introduction

Adhesive bonding is important in orthodontics, especially in terms of the fixation of brackets to the teeth. The success of fixed-appliances therapy depends on the capability of the adhesive system to resist failure with a large number of forces directed to the bracket/adhesive/enamel as well as to allow for easy removal after treatment without causing enamel damage. Currently, the most commonly used adhesives for orthodontic bracket bonding are based on composite resin. Glass ionomer systems have certain advantages [1–3], but their use in orthodontic bracket bonding has been limited due to inferior mechanical properties, in particular bond strength [4,5].

Apart from the adhesives used, the design of the bracket has a great role in the fixation of the brackets to the teeth. The evolution of brackets has included modifications of bracket-base design to achieve satisfactory bond strength, with mechanical base–adhesive and adhesive–enamel retention while facilitating debonding without damage to the enamel surface [6–8].

In 1984, an attempt was made by Artun and Bergland [9] to subjectively register the force necessary to remove the brackets. The purpose of their study was to test the applicability of two crystal bonding agents in routine clinical orthodontic practice, using two test solutions containing sulfuric acid. An adhesive remnant index (ARI) system was used for the first time to evaluate the amount of adhesive left on the tooth after debracketing. Since its introduction, the index has had multiple uses and evaluations [10–15].

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The purpose of this study was to determine the effects on ARI of two different orthodontic adhesives (composite resin and resin-modified glass ionomer cement) and two different bracket-base designs (conventional mesh base and laser-etched base).

2. Methods and materials

The study of the effects of the two different bonding materials (a composite resin [Transbond XT etching gel, light cure adhesive primer, and paste, 3M-Unitek, Monrovia, CA] and a resin-modified glass ionomer [radiopaque luting cement, Fuji Ortho, Tokyo, Japan]) and two different bracket-base designs (Mini Sprint, 0.018-in slot, Roth prescription [Forestadent, Pforzheim, Germany] and equilibrium 2, 0.018-in slot, Roth prescription [Dentaraum, Pforzheim, Germany]) in relation to ARI was done in vitro in freshly prepared specimens. The sample consisted of 32 extracted premolars bonded in the laboratory. The inclusion criteria for the use of premolars were: no carious lesions, intact labial surface, no restorations, and no defects on the enamel. The teeth were stored in distilled water at room temperature. All of the premolars were cleaned and polished and randomly assigned to one of four groups: group A, conventional mesh base and composite resin; group B, laser-etched base and composite resin; group C, conventional mesh base and resin-modifying glass-ionomer (RMGI) cement; and group D, laser-etched base and RMGI cement.

In group A, eight premolars were bonded with edgewise brackets (Mini Sprint) using composite resin (Transbond XT), following the manufacturer's instructions. In group B, eight premolars were bonded using laser-etched metallic brackets (equilibrium 2) using a composite resin (Transbond XT), following the manufacturer's instructions. In group C, eight premolars were bonded with edgewise brackets (Mini Sprint) using a resin-modified glass ionomer (radiopaque luting cement). Finally, in group D, eight premolars were bonded with laser-etched metallic brackets (equilibrium 2) using resin-modified glass ionomer (radiopaque luting cement). Before resin bonding, the enamel was etched with 35% phosphoric acid gel (Transbond XT) for 30 seconds. For the light-curing of the composite resin, a halogen lamp was used and the polymerizing time was 40 seconds. After bonding, the specimens were left in distilled water for a week before debonding. After a week, the brackets were debonded using Hu-Friedy straight bracket-removing pliers. The debonded bracket-base surface as well as the buccal surface of the each tooth were studied under a stereomicroscope (Leica M80, Leica Microsystems, Wetzlar, Germany) at a magnification of ×10 and were photographed with a digital camera color camera system (Leica DFC295, Leica Microsystems), which was connected to the microscope.

Finally, the percentage coverage of the tooth surface with the adhesives was also examined in relation to the ARI with the help of AutoCAD designing and drafting software (Autodesk Inc., San Rafael, CA).

ARI on all 32 teeth was measured directly from the digital images of the teeth.

2.1. Adhesive remnant index

The ARI is a 4-point scale with scores defined as follows: 0 = no adhesive left on the tooth; 1 = less than half of the adhesive left on the tooth; 2 = more than half of the adhesive left on the tooth; and 3 = all of the adhesive left on the tooth, with a distinct impression of the bracket mesh.

The percentage coverage of the tooth with remnants of the orthodontic adhesive was calculated after the processing of the digital images with the designing and drafting software (Figs. 1 and 2).

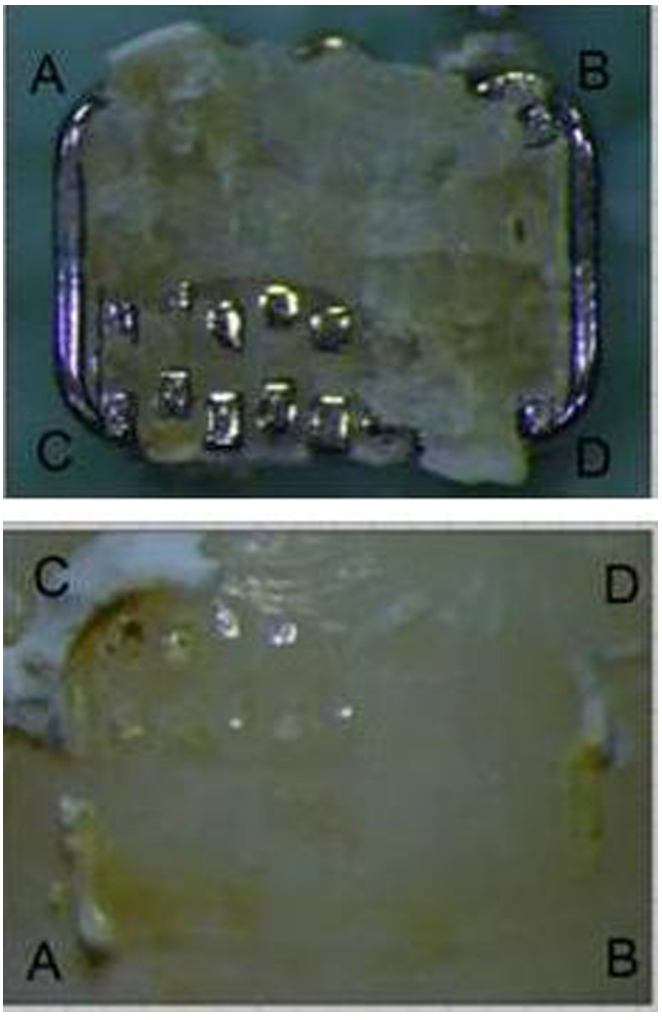

Fig. 1. The two images are inserted into AutoCAD (Autodesk Inc., San Rafael, CA), and the area of the bracket is outlined and calculated.

A ratio was created, as follows: (Sum of areas of adhesive left on the tooth surface)/(Total area of tooth surface covered by the bracket).

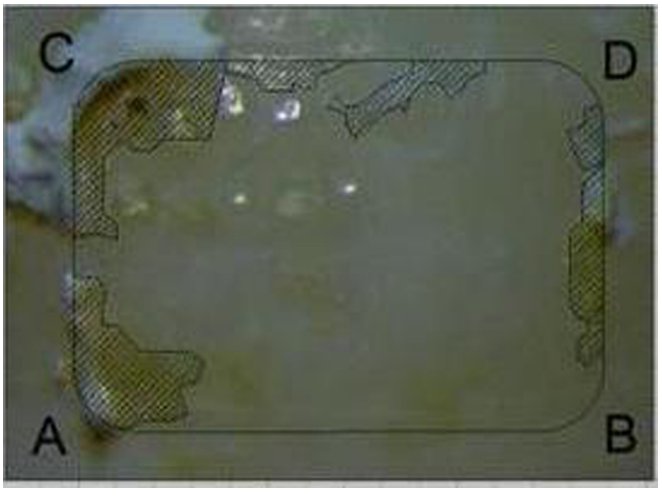

Fig. 2. The area covered by the adhesive is outlined.