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ORIGINAL ARTICLE

Microshear bond strength to dentin of self-adhesive flowable composite compared with total-etch and all-in-one adhesives

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KEYWORDS
microshear bond strength;
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Abstract *Background/purpose:* Because of the lack of data on long-term survival of a flowable self-adhesive composite (SAC) restoration, the purpose of this study was to compare the microshear bond strengths (μSBSs) of flowable resin composites to dentin, either with self-adhesive ability or with the combined use of a total-etch adhesive and all-in-one adhesive, before and after thermocycling.
Materials and methods: Coronal dentin specimens of 60 extracted sound third human molars were divided into three groups ($n = 20$) as follows: Group 1, flowable SAC (VF); Group 2, total-etch adhesive + flowable composite (FL); Group 3, all-in-one adhesive + flowable composite (AL). For each adhesive, half of the specimens were subjected to μSBS testing after 24-hour water storage, and the other half of the specimens were subjected to 5000 thermocycles followed by μSBS testing. The morphologies of the adhesive interfaces were evaluated under a scanning electron microscope. Data were analyzed using one-way analysis of variance (ANOVA) and independent *t* test.
Results: One-way ANOVA showed similar results for both 24-hour water storage and thermocycled groups. The FL group showed the highest μSBS values ($P < 0.001$). The VF and AL groups were not statistically significantly different. Thermocycling had no effect on μSBS values ($P = 0.578$). The interfacial observation revealed that VF had a gap at the resin–dentin interface. By contrast, both FL and AL specimens had distinct adhesive layers without any gap formation.

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Conclusion: The results from this study indicated that laboratory bonding effectiveness of flowable SAC was approximately that of all-in-one adhesive.

Introduction

To meet the increasing esthetic demands of patients, a tooth-colored material with simplified clinical steps is highly desirable, not only for clinical efficiency but also for less technique sensitivity. Therefore, a flowable self-adhesive composite (SAC) has been developed as it does not require any pretreatment of the tooth.[1] The SAC can bond directly to the tooth using self-etching adhesive technology combined with a conventional flowable resin composite. The composition of SAC is similar to other flowable resin composites but includes acidic (functional) monomers such as glycerol phosphate dimethacrylate (GPDM) and 4-methacryloxyethyl trimellitic acid (4-MET) used in current dental adhesives.[2] Thus, the SAC can simultaneously demineralize and infiltrate the tooth structure, resulting in micromechanical retention.[1,3,4] In addition, the bonding performance may be enhanced by the additional chemical treatments, depending on the acidic monomer used.[5,6]

In this study, the bonding performance of an SAC was investigated using the microshear bond strength (μSBS) test. Recent studies have reported the bond-strength values of SAC when tested immediately after application.[3,4,7] However, long-term survival of the tooth—restoration interface in the oral cavity with temperature change, chewing loads, and chemical attack is a challenge.[8] Thus, an artificial aging process is more likely to represent long-term clinical bonding performance. In this study, aging by thermocycling was selected, as recommended by the International Organization for Standardization (ISO).[9]

The aim of this study was to compare μSBS values of SAC with flowable resin composite combined with a total-etch or an all-in-one adhesive to dentin before and after thermocycling. The null hypotheses were as follows: (1) there was no difference in μSBS of SAC, total-etch adhesive, and all-in-one adhesive to dentin after both 24-hour water storage and 5000-cycle thermocycles; (2) there was no difference in μSBS of each material tested before and after thermocycling.

Materials and methods

Sixty sound third human molars were used following approval of the protocol by the Human Research Ethics Committee, Faculty of Dentistry, Chulalongkorn University. The teeth were extracted, cleaned, and immersed in 0.1% thymol solution at room temperature for 7 days, stored in distilled water at 4°C, and used within 6 months. The teeth were sectioned at the occlusal third of the crown and approximately 2 mm below the cementoenamel junction (Figure 1A) with a slow-speed diamond saw (Isomet; Buehler, Lake Bluff, IL, USA) under water cooling. The resulting dentin specimens (Figure 1B) were embedded with the coronal surface exposed in polyvinyl chloride tubes using epoxy resin (Figure 1C), polished using wet 600-grit silicon carbide paper for 60 seconds to create standardized smear layer, randomly divided into three groups according to the adhesive systems, and restored according to the respective manufacturers' instructions (Table 1).

After the adhesive application, three clear cylindrical plastic tubes, 0.8 mm internal diameter × 1.0 mm height (Tygon tubing; Norton Performance Plastic Co, Cleveland, OH, USA), were placed on the flat dentin surface (Figure 1D) and subjected to adhesive light curing for 20 seconds. After curing, each tube was filled with flowable resin composite: Group 1 (VF), shade A3.5 Vertise Flow (Kerr Corporation, Orange, CA, USA); Group 2 (FL), OptiBond FL (Kerr Corporation) + shade A3.5 Premise Flowable (Kerr Corporation); Group 3 (AL), OptiBond all-in-one (Kerr Corporation) + shade A3.5 Premise Flowable (Kerr Corporation) and light cured for 40 seconds. The light output intensity was not less than 800 mW/cm^2, checked using a radiometer (Kerr Corporation).

All specimens were stored in water at 37°C for 24 hours. The plastic tubes were removed and specimens were examined under a 10× magnification stereomicroscope (ML 9300; MEIJI TECHNO, Saitama, Japan) to evaluate the integrity of the resin—dentin interface. Any specimens with interfacial gaps, bubbles, or any defects were excluded from the study. For each adhesive, half of the specimens were subjected to μSBS test immediately after the tube removal and the other half of the specimens were subjected to thermocycling between 5°C and 55°C for 5000 cycles. The dwell time and transfer time were 30 seconds and 10 seconds, respectively.

Specimens were mounted in a universal testing machine (EZ-S; Shimadzu, Tokyo, Japan), a 0.4-mm thick blade placed parallel and adjacent to the resin—dentin interface and specimens were tested to failure at a crosshead speed of 1.0 mm/min. All specimens were analyzed for mode of failure using a stereomicroscope at 45× magnification and categorized as adhesive, cohesive in dentin, cohesive in resin composite, or mixed. Representative specimens were randomly selected for fractographic examination by scanning electron microscopy (SEM) at 2000× magnification (JSM-5410LV; JEOL, Tokyo, Japan)

For dentin—resin interface observations, the resin-bonded specimens were prepared as for μSBS test specimens and sectioned perpendicular to the adhesive interface using a slow-speed saw under running water to obtain 2-mm thick dentin slices. The sectioned surfaces were sequentially polished with 600-, 800-, and 1,000-grit silicon carbide papers under running water, followed by treatment with 1.0- and 0.4-μm aluminum oxide polishing pastes and cleaning with an ultrasonic device. The specimens were immersed in 1M hydrochloric acid for 30 seconds followed by treatment with 5% sodium hypochlorite for 5