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Use of dental adhesives as modeler liquid of resin composites

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ABSTRACT

Objectives. Resin adhesives (RA) have been applied between resin composite (RC) increments, but there is no consensus on the impact of this technique on the properties of the final restoration. This study evaluated the effect of the presence of RA between RC layers on physical properties, translucency and long-term color stability of the restorative material.

Methods. Scotchbond™ Multi-Purpose (bond, 3M ESPE) and Adper™ Single Bond 2 (3M ESPE) were used as RA, and Filtek™ Z350 (3M ESPE) as RC. Specimens containing RA were prepared by applying 3 layers of the adhesive between 4 increments of RC; adhesive-free specimens were also used (control). Tests of water sorption and solubility, mechanical performance (microtensile cohesive strength, flexural strength, and flexural modulus, after immediate and long-term water storage), and translucency and color stability (after immediate and 1, 7, 90, and 180 days of water or wine storage) were performed. Scanning electron microscopy (SEM) images were also taken from the fractured specimens (flexural strength test). Data were analyzed using ANOVA and Tukey test ($p < 0.05$).

Results. Scotchbond (SBMP) showed lower water sorption and solubility than the control ($p < 0.001$), and an overall similar ($p \geq 0.198$, immediate tests) or higher ($p \leq 0.019$, long-term tests) mechanical performance. SBMP exhibited a rougher cross-sectional surface compared to the other groups. Translucency remained unaltered after 180 days of storage ($p \geq 0.313$), except for single bond that had increased translucency with wine storage ($p < 0.045$). After 180 days, all groups changed color ($p \leq 0.002$), although more intensively when immersed in wine.

Significance. The presence of RA within RC increments increased the physical stability of the material, being this effect more evident by using the hydrophobic unfilled adhesive resin (SBMP). This study is the first to show positive results from the use of resin adhesives as modeler liquid of resin composite, which is common in clinical practice.

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1. Introduction

Dental resin composites have been widely used as direct/indirect restoratives mainly due to their excellent esthetic properties [1]. However, despite of all satisfactory properties expected when using current composites [2–4], some materials are comprised of viscous resin monomers that make it difficult to sculpt and to model the composite in the anatomical shape of the tooth. Consequently, some continuous education courses on restorative dentistry as well as some dental practitioners/dentists are advocating the use of low viscous materials (e.g., resin adhesives) as 'modeler liquids' of resin composites. This approach would be able to reduce the surface tension improving the handling/placement of the restorative material in the cavity or dental preparation. Indeed, the 'build-up' process of dental ceramic restorations uses modeler liquids to mix the powder, which reduces the surface tension produced between the material and the spatula/instruments, making the layer-by-layer placement of material easier [5].

As aforementioned, resin adhesives have been used as modeler liquids of resin composites, although manufacturers do not report this technique. The technique consists of applying the adhesive on the surface of the first composite increments before light curing, and/or on the spatula/instrument, enabling the easy modeling of the next increment. This technique may be also useful for reducing air entrapment and porosity/defects into the restoration body since the low viscous resin may easily penetrate through these spaces [6]. However, to the best of our knowledge, there is no report in the literature investigating if the presence of modeler liquid into the composite structure may affect the final quality/properties of the restoration/composite. Moreover, it is unknown whether the different compositions of adhesives/modeler liquids may affect the translucency and color stability of composite over time.

Hence, the aim of this in vitro study was to investigate the effect of the presence of resin adhesive between layers of resin composites on the physical properties, translucency and long-term color stability of the restorative material. Three hypotheses were tested: (1) the presence of adhesive into the composite structure would not reduce its mechanical strength; (2) the presence of adhesive into the composite structure would alter the translucency and the color shade of the composite after storage when compared to a bulk adhesive-free composite; and (3) the type of adhesive applied would influence on the long-term translucency and color stability of the composite.

2. Materials and methods

2.1. Study design

This in vitro study used resin composite specimens (Filtek™ Z350 XT, 3M ESPE, St. Paul, MN, USA) with or without modeler liquid (resin adhesive) in order to investigate the effect of the latter on long term physical properties, translucency, and color stability of the composite. For that, two different resin adhesives were used as modeler liquids: SBMP (the bond component of Adper™ Scotchbond™ Multi-Purpose Adhesive, 3M ESPE) as a more hydrophobic composition, and SB (Adper™ Single Bond 2 Adhesive, 3M ESPE) as a more hydrophilic material. All specimens were prepared by placing four increments of resin composite. Specimens containing modeler liquid were prepared as it follows: after the placement of the first composite increment, the respective adhesive resin was applied on the composite surface with a disposable brush (Microbrush® International, Grafton, WI, USA); next, a new increment of composite was placed, modeled, and coated with another layer/pellicle of the modeler liquid, until the fourth increment was placed. The modeler liquid was not directly light-activated since it was mixed and entrapped within the composite's increments, which were light-activated separately (for specimens thicker than 2 mm) or only after placement of the fourth increment (for specimens with 2 mm of thickness). Specimens without adhesive were prepared as control group. Each set of specimens was prepared varying the format and thickness of the specimen, in accordance with each test performed, aiming the simulation of a restoration in clinical practice with additional/intermediate layers of resin adhesive; the thickness of each composite increment has never exceeded 2 mm.

2.2. Microtensile cohesive strength (μTCS) test

Six cylinder-shaped specimens (6 mm diameter × 6 mm thickness) of each group were prepared. Each increment of composite (around 1.5 mm-thick) was light-activated for 20 s using a light-emitting diode (LED, Radii®, Bayswater, VIC, Australia – 900 mW/cm^2 of irradiance) curing unit. The samples were stored in distilled water for 24 h at 37 °C, and then transversally and longitudinally sectioned using a water-cooled diamond saw at low speed (Isomet 1000, Buheler Ltd, Lake Bluff, IL, USA) to obtain specimens with approximately 0.8 mm^2 of transverse-sectional area. All specimens were randomly allocated in two subgroups according to the period of storage in distilled water (37 °C): immediate (24 h) or long-term (6 months). After that, each specimen was fixed to a custom-made testing jig using cyanoacrylate glue (Super Bonder Gel, Loctite, Brazil) and its μTCS was tested in a universal testing machine (DL500, Emic, São José dos Pinhais, Brazil) at a crosshead speed of 1 mm/min. The μTCS results were expressed in MPa.

2.3. Flexural strength, flexural modulus, and scanning electron microscopy (SEM) analyses

Ten bar-shaped specimens (25 mm length × 2 mm width × 2 mm thickness) of each group were prepared, and light-activation for 20 s was performed in four consecutive points of both top and bottom surfaces of each specimen. Next, the specimens were randomly allocated into two subgroups according to the period of storage in distilled water at 37 °C ($n = 5$): 24 h or 7 days. All specimens were then submitted to three-point bend test in the DL500 universal testing machine at a crosshead speed of 1 mm/min. The