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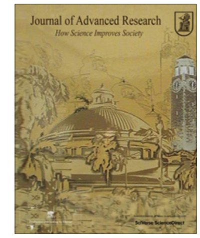

ORIGINAL ARTICLE

Repair bond strength of dual-cured resin composite core buildup materials

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ABSTRACT

The reparability of dual-cured resin composite core buildup materials using a light-cured one following one week or three months storage, prior to repair was evaluated. Two different dual-cured resin composites; Cosmecore™ DC automix and Clearfil™ DC automix core buildup materials and a light-cured nanofilled resin composite; Filtek™ Z350 XT were used. Substrate specimens were prepared (n = 12/each substrate material) and stored in artificial saliva at 37 °C either for one week or three months. Afterward, all specimens were ground flat, etched using Scotchbond™ phosphoric acid etchant and received Single Bond Universal adhesive system according to the manufacturers' instructions. The light-cured nanofilled resin composite (Filtek™ Z350 XT) was used as a repair material buildup. To determine the cohesive strength of each solid substrate material, additional specimens from each core material (n = 12) were prepared and stored for the same periods. Five sticks (0.8 ± 0.01 mm^2) were obtained from each specimen (30 sticks/group) for microtensile bond strength (μTBS) testing. Modes of failure were also determined. Two-way ANOVA revealed a significant effect for the core materials but not for the storage periods or their interaction. After one week, dual-cured resin composite core buildup materials (Cosmecore™ DC and Clearfil™ DC) achieved significantly higher repair μTBS than the light-cured nanofilled resin composite (Filtek™ Z350 XT). However, Clearfil™ DC revealed the highest value, then Cosmecore™ DC and Filtek™ Z350 XT, following storage for 3-month. Repair strength values recovered 64–86% of the cohesive strengths of solid substrate materials. The predominant mode of failure was the mixed type. Dual-cured resin composite core buildup materials revealed acceptable repair bond strength values even after 3-month storage.

Introduction

Core buildup restorations are often required for rebuilding severely damaged teeth with compromised resistance and retention prior to receiving indirect restorations. The improved strength, load transfer characteristics and durability along with advances in adhesive technologies directed conservative dentistry toward the use of resin composites as core buildup materials [1]. Resin based core buildup materials are available

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in self-cured, light-cured and dual-cured formulations. For the building of extensively damaged teeth, some clinicians currently prefer the use of dual-cured resin composites [2]. This type of resin composite is utilized to overcome the limitations of both extended chairside time [3], and depth of cure problems [4] that can occur with incremental layering techniques [5]. Dual-cured resin composite buildup restoratives combine the advantages of light- and self-cured mechanisms, in regard to a redox initiator system and photoinitiators [6] Polymerization is mainly initiated by light activation in the superficial layers of the materials and by chemical activation in the deeper layers even when the curing light is severely attenuated [7].

During the treatment phase of full mouth rehabilitation some cases needs temporary cemented tentative restoration over the core buildup for a period of time until other steps of the treatment plan is achieved and the final indirect restoration is finally cemented. In some instances, such temporization could be debonded and part of the core material with or without the tooth chipped or partially fractured due to sudden biting on hard object before the tentative restoration is re-cemented. In this case, the clinicians are faced with the dilemma of selecting the optimal method for reconstruction [8]. Total replacement of defective core buildup materials results in a more invasive treatment with increased risk of complications and successive tooth loss in the future [9]. Additionally, core buildup replacement increases the cost of the procedure especially when a large portion of the restoration is clinically and radiographically intact [8] At variance, repair provides an extended service and longevity for the existing restoration. The ability to repair light-cured resin composite materials was validated by many researchers [10].

In a literature survey, there were no data available on the repair potential of the dual-cured resin composite core buildup materials as to whether the fracture occurred shortly after preparation or later. Therefore, this study was carried out to evaluate the repair bond strength of stored (one week or three months) dual-cured resin composite core materials. The tested null hypotheses were (1) there is no difference among core materials repair strength values; (2) there is no difference in repair strength values with both storage periods prior to repair (one week and three months).

Experimental

Preparation of the substrate specimens

A total of 36 substrate resin composite specimens were prepared for this study. The materials, manufacturers, composition and batch numbers are listed in Table 1. The specimens were divided according to the core resin composite restorative material into three groups ($n = 12$/group). The first group included a light-cured resin composite restorative material [Filtek™ Z350 XT Universal Restorative, 3M ESPE, St. Paul, MN, USA, dentin shade (A_2)] and the other two groups included different dual-cured resin composite core materials; [Cosmecore™ DC core automix (Cosmedent America, Chicago, USA), dentin shade (A_2)]; [Clearfil™ DC core automix (Kuraray Noritake, Tokyo, Japan), Dentin shade (A_2)]. Each resin composite core material was inserted in a split Teflon mold (4 mm diameter × 4 mm thickness) placed on top of a Mylar strip (Dental Technologies, Illinois, USA) and a glass slab. The light-cured resin composite (Filtek™ Z350 XT) was applied in two increments of 2 mm each, while the dual-cured resin composite core materials (Cosmecore™ DC and Clearfil™ DC) were automixed before their application into the mold according to their manufacturers' instructions. The top of the increment was also covered with a Mylar strip and compressed with a glass slide to obtain a flat surface of the specimen. The top and bottom surfaces of the resin composite were cured from both sides for 20 s each using LED light curing unit (Blue Phase C5, Ivoclar Vivadent, Schaan, Liechtenstein) with an output light intensity of 450 mW/cm^2, periodically checked using an LED radiometer (Kerr Dental Specialties, West Collins Orange, CA, USA). After curing, the specimens were removed from the mold and checked using a magnification loupe (HEINE Optotechnik, Herrsching, Germany). The remaining fine flashes were carefully removed using a sharp lancet (Wuxi Xinda Ltd., Shanghai, China). Flashes were manually removed using a 220 grit SiC paper [11]. The base of each specimen was marked using an indelible type of markers (Sharpie®, Illinois, USA) of different colors to facilitate differentiation of the specimens. Specimens were then stored in artificial saliva [12] for one week or three months at 37 °C in a thermal incubator (Egyptian Medical Co., Cairo, Egypt). Artificial saliva solution was replaced weekly [13].

Repair of the substrates specimens

After the assigned storage periods, specimens were surface treated in two steps. First, the surface was wet-ground flat using a diamond wheel stone (Komet, Gebr.GmbH@ Co., Germany) [14]. Each specimen was then washed with tap water for 30 s and blotted dry. A digital caliper, (Mitutoyo digital caliper, Mitutoyo Corp., Kawasaki, Japan) was used to check that only 150–200 μm was removed from the height of each specimen. All specimens received acid etching with 37% phosphoric acid (Scotchbond etchant gel, 3MESPE, St. Paul, MN, USA) for 15 s followed by rinsing with water for another 15 s and then were air-dried for five seconds from a distance of 1 cm. Single Bond Universal Adhesive system (3M ESPE, St. Paul, MN, USA), was applied to the substrate surfaces using a microbrush (Shanghai Dochem Industries Co., Ltd., Shanghai, China) and gently agitated for 20 s. The adhesive was gently air dried for five seconds and light-cured for 10 s with light curing unit according to the manufacturers' instructions.

The treated substrate specimen was then inserted into another specially constructed repair mold (4 mm diameter × 7.5 mm thickness) while the treated surface was directed upwards. Such height was obtained by assembling three split Teflon molds over each other; the first one with a height of 3.5 mm, the second one with a height of 2 mm and the last one with a height of 2 mm. Specimens were repaired using light-cured resin composite (Filtek™ Z350 XT) (shade B_2). A different shade was chosen for the repairing composite to enable visual identification and orientation of the repair interface during microtensile bond strength (μTBS) testing and failure mode observation [15]. The repairing composite was packed against the treated side of the substrate specimen incrementally (1.5 mm thick followed by 2 mm thick). Each increment was cured for 20 s. In order to test the cohesive strength of the tested materials, additional specimens of