Effect of Different Adhesives and Aging Periods on the Shear Bond Strength of a Repaired Bulk Fill Resin Composite

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By increasing the use of composite restorations, some defects can be seen in these restorations, which can lead to clinical failure of the restorations [1]. Repair of the preexisting restoration is more conservative than replacement as it can increase the restoration longevity, preserve the sound tooth structure and decrease operative trauma [2]. There is still a debate about the best repair technique. Therefore, a combination of mechanical and chemical methods is often used to improve the bond between new and aged resin composite.

Mechanical pretreatment of composite surface is performed to remove superficial layer to expose a clean composite surface with high energy and increasing irregularities to promote mechanical interlocking [3]. diamond bur roughening and acid etching with phosphoric acid as surface treatment in repair procedure are the most common and easy repair approach that does not need additional tools[4]. Applications of resin adhesives enhance surface wetting and chemical bonding between new and aged composite [3]. A silane coupling agent has been added to universal adhesives as it is considered that it has beneficial effect in restoration repairs [5].

Bulk-fill resin composites were introduced to overcome the need for resin composite layering and adapting procedures which cause time-consuming, air entrapment and contamination. They allow for the placement of materials in 4 mm increments without compromising cure and increasing shrinkage [6].

During clinical service or aging of resin composite; surface interact with the surrounding environment, water is absorbed causing softening of the matrix, formation of micro-cracks, resin degradation, deboning of the filler/matrix surface and leaching out of some constituents. This could negatively affect the repair bond strength [7].

Shear bond strength test is the most widely used test since no further processing of the specimen was required after the bonding procedure, it is the easiest and fastest method and it produces elements of tensile, shear and compressive stress that often occur during chewing [8].Therefore, it was thought that it would be valuable to evaluate the effect of an acid etchant with previous roughening by a diamond bur, different adhesives and aging periods on the shear bond strength of a repaired bulk fill resin composite.

1. Bulk fill resin composite

Resin-based composites are increasingly being used to restore posterior teeth, due to increased aesthetic demands of the patients and that resin composites are tooth-colored and mercury-free restorations which adhesively bonded to the tooth with a compatible bonding system allowing for a conservative cavity preparation, Studies are increasingly supporting the longevity of resin composite as a material for restoring both Class I and II cavities [9, 10].

The placement of posterior resin composite restorations, however, is not without its limitations. Proper tooth isolation is needed and an incremental layering technique is currently recommended. The layering of resin based composites improves light penetration allowing for complete polymerisation of the material and is thought to decrease overall polymerisation shrinkage stresses on the tooth. However, this technique can be time consuming and may cause air bubble inclusion or moisture contamination between individual increments of resin composite restorations. If not carried out effectively, areas of partially cured or uncured composite resin may remain at the base or between layers at the bottom of each increment. This can cause reduction in strength, prevent adequate sealing of the restoration or lead to post-operative sensitivity and early restoration failure [9, 10, 11].

To simplify and accelerate the placement of large posterior composite resin restoration, manufacturers have developed a range of materials that can be placed in single increments, known as bulk-fill resin based composites. Over a relatively short period of time many bulk-fill resin based composites have been marketed quoting increment depths equal or more than 4 mm. The application of these larger increments of composite resin may reduce the time needed when placing posterior restorations and thereby reduce technique sensitivity [12,13].

Bulk-fill resin composite restorative materials categorized into high-viscosity or low-viscosity, light or dual cured. All of the bulk-fill restorative materials can be capped with conventional composite resin to improve their aesthetics or physical characteristics of the restoration [9,10,14].

Manufacturers have attempted to increase curing depth by several methods including: Reducing the filler content, Increasing filler particle size and usage of additional innovated photo-initiators. Reducing the filler content and increasing the filler size within composite resin reduces the amount of light scatter at the resin-filler interface and increases the amount of absorbed light. EvoCeram Bulk-fill increases the curing depth by using several different photo-initiators. The manufacturers claim that it is the addition of photo-initiator which is highly reactive, named Ivocerin allowing it to be polymerised in larger increments, when compared to standard photo-initiators such as, camphorquinone or lucririn [15].

The manufacturers of bulk-fill materials claim lower polymerisation stresses than conventional resin based composites when placed in greater increment thickness .This new and innovate technology is based on changes in the chemistry of the monomer. Which achieved by incorporating hydroxyl free Bis-GMA, aliphatic urethane dimethacrylates, partially aromatic urethane dimethacrylate, or highly branched methacrylates. The outcomes of these changes in composite organic matrix and monomer have been shown to reduce stresses of polymerization shrinkage over 70% [16,17]. Other manufacturers have altered the shrinkage stress effect by inclusion of shrinkage stress relievers which have a lower elastic modulus which includes a polymerisation modulator which interacts with the camphorquinone photo initiator to result in a slower elasticity modulus development [9].

Aesthetics are greatly improved with all resin based composite materials in comparison to amalgam, although bulk-fill materials may be limited in terms of shade and translucency of the materials in compared to conventional hybrid resin composite. For patients in which ultimate aesthetics are a mandatory, a capping layer of conventional hybrid composite resin is indicated and is compatible with most bulk-fill materials [11].

The reality is that currently bulk-fill resin composite restorative materials have little clinical research to support their use [9]. However, it is reported that the bulk-fill composites were comparable to the traditional multi-increment–fill resin-based composites when measured against an international standard [18], and that the bulk-fill composite resin materials showed similar clinical performance when compared with a conventional posterior composite resin [19,20].But little is yet known about the behavior of bulk-fill composite in composite resin restoration repair [21].

Tavarez et al, 2017 [21], evaluated Shear bond strength of different surface pretreatments in bulk fill, micro hybrid, and nanoparticle repair resins. Seventy-two, specimens were prepared using a nanoparticle resin composite. Then, the specimens were repaired with micro hybrid resin P60 (3M ESPE), nanoparticle resin Filtek Z350 (3M ESPE) and Bulk Fill Surefil SDR Flow (Dentsply) composite resins. before the surfaces of the samples were treated, the following subgroups (n=12): (A) etched with37% phosphoric acid for 30 s, and (B) abraded with a diamond tip for 3 s and etched with 37% phosphoric acid. In all groups, before the insertion of the repair composite resin, the adhesive system was applied and photo polymerized. The results revealed that bulk-fill resin composite had a significant statistical decrease in bond strength compared to conventional nanoparticle and micro hybrid resin composites and that roughening with diamond bur followed by phosphoric acid etching showed values higher than the exclusive use of acid. They concluded that the repair bond strength of the composite resin repair varies according to the type of resin composite used, and that roughening of the surface increased the repair bond strength.

Ayar et al,2018[22],assessed the ability of posterior resin composite to repair aged bulk-fill resin composite and vice versa with different surface treatments .Resin composite specimens prepared by individually filling shaped cavities (2 mm depth and 6 mm diameter) in a Plexiglas block and aged, then bulk-fill specimens were repaired with posterior resin composite and vice versa using different surface pretreatments (no surface treatment [control]; etching with 37%phosphoric acid [H_3PO_4] for 20 seconds; etching with 10% hydrofluoric acid [HF] for 20 seconds; etching with 37% H_3PO_4 for 20 seconds and adhesive application; etching with 10% HF for20 seconds and adhesive application; adhesive application only).repair resin composite was then using a two-piece Plexiglas mold with dimensions of (3×3) mm. Shear bond strengths (SBS) were then measured and surface roughness values (Ra) were determined. Cohesive strengths of unaged resin composites were measured and used as reference groups. After acid etching resin composite surfaces were evaluated by SEM. Results showed that resin composite repair type did not significantly affect the shear bond strength, while surface treatments affected the shear bond strength significantly. They concluded that the aged bulk-fill resin composite would be effectively repaired with conventional posterior resin composite or vice versa if proper repair protocol was deployed.