

## Literature Review

# Bulk fill composite resins: How predictable is restoring posterior teeth in one increment?

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## ABSTRACT

Bulk fill composite is a new type of resin restorative material that promises a greater depth of cure up to 4mm and similar physico-mechanical properties with conventional nano-hybrid or micro-hybrid composites.

Despite the lack of adequate clinical trials, this material has gained popularity among the dental profession due to the ease of application and thus reduction in the treatment time. The objective of this article is to review the existing literature and examine if adequate scientific evidence supports the clinical use of these materials in vivo. Two clinical cases are presented.

## INTRODUCTION

Dental composite resin is considered the material of choice today for the anterior as well as the posterior direct restorations. Since their introduction, composite resins have gone through major changes, mainly in filler size and type as well as other changes in the resin matrix and other components. However, challenges are still present in the recent nano-hybrid composites. The major problems related to composites are polymerization shrinkage and the associated shrinkage stress, especially in cavities with high c-factor (c-factor is defined as the ratio between bonded and unbonded tooth surfaces) 1, depth of cure and marginal leakage 2.

Incremental placement of layers up to 2mm has been the standard for direct composite application. It is governed by many factors that include the translucency and shade of the material, the polymerization initiators and the exposure time and light intensity 3, 4

Another disadvantage of the conventional composites is the quality and durability of marginal adaptation. Manufacturers have introduced materials with lower viscosity, the flowable composites, with reduced filler content of up to 20%. Flowable composites can be applied as cavity liners or stress breakers, but the low filler content affects adversely the wear resistance, polymerization shrinkage and strength of the material.

Significant advances have been made in composite formulations that target to make the materials more user friendly, by having the ability of bulk placement in one layer of up to 4mm thus reducing the time needed to restore a tooth, while maintaining or even reducing shrinkage stresses developed after curing and have been introduced in the market under the name of bulk fill composites 6-10.

The aim of this article is to review the existing literature and examine if adequate scientific evidence supports the clinical use of these materials in vivo.

**MATERIALS AND METHODS:** This literature review was performed using PubMed database and no publication year limit was applied. Search keywords/Medical Subject

Headings were as follows: bulk fill, dental composites, flowable composites, packable composites

Categories of bulk fill composite resin materials:

1. Sculptable (paste viscosity) Bulk Fill composites: Bulk Fill composites in conventional paste consistency were launched and they can be used as a single step bulk filling material. The photo initiator system in bulk fill resin based composites remained Camphorquinone (CQ) based, similar to the regular light cured resin based composites except one material that contains a germanium based photo initiator named by the manufacturer Ivocerin ( Tetric Evo Ceram Bulk Fill, Ivoclar Vivadent, Schaan, Lichtenstein )6,7. This dibenzoyl germanium initiator system has an absorption spectrum very close to that of CQ and was reported to have a higher photo curing activity than CQ, due to its higher absorption of visible light. Curing in higher depth is also facilitated by increasing the translucency of the materials 12,13.

2. Flowable Bulk Fill composites

This is an advanced version of flowable composites, for simplifying and speeding the restorative procedure. Some of the bulk fill flowable composites have been claimed by the manufacturers to be fluoride releasing 10, 11, 13, and can be placed and bulk cured in one increment up to 4mm with minimal polymerization stress. The matrix composition of the bulk fill flowable composites is based on modified urethane dimethacrylate (UDMA) which is a polymerization modulator. It contributes to prolong the gel stage of polymerization so that the molecules have time to rearrange, which represents an increase of viscosity through network formation and allows for a greater pre-gelation phase time. This results in a slower modulus development, allowing for stress reduction without decreasing conversion rate (depth of cure) 11, 13. Bulk fill flowable composites show similar polymerization shrinkage and shrinkage stress compared with conventional resin composites, satisfactory micro-tensile bond strength, depth of cure, degree of conversion and flexural strength 14-

16. However, these materials require the placement of a final capping layer of a conventional composite material on top of the flowable composite base, as a result of their low surface hardness and low modulus of elasticity.

3. **Highly Filled Flowable Bulk Fill composites**  
Highly filled flowable composites have higher filler content and improved mechanical properties. Manufacturer's recommendations include their use for all classes of restorations 8.

**Depth of cure**  
The major concern for a material that can be placed in bulk is the capability to provide equal degree of conversion to the whole mass of the material and hence increased curing efficacy. The degree of conversion is directly related to the effective curing time 17-18. A study has found that the bulk fill materials can achieve up to 80% degree of conversion in the 4mm thickness after 30s of irradiation time but appears to be worse for 10s 18. ISO 4049 is a standard used for defining the maximal curing increment thickness of resin composites, however, in the bulk fill materials the ISO 4049 was found to overestimate the depth of cure compared to the depth of cure determined by Vickers hardness profiles 19.

Bond strength values can be also used to evaluate adequate curing. Under-cured material is most likely to exist at the deepest part of the increment and thus, it may adversely affect the adhesion and the bond strength. One study found that no significant differences in gap-free margins were found between placement methods within a given product in the enamel, mid-dentin and pulpal floor. Except for the flowable type of bulk fill, the percentage of gap-free margins was significantly lower at the pulpal floor interface than at the enamel interface 20.

In one in vitro study that compared the micro-leakage for enamel and dentin before and after artificial aging they found that bulk fill flowable resins provided better marginal seal in dentin, while at enamel margins nanohybrid resin composites and bulk fill flowable resins showed similar microleakage values. 21

**Polymerization shrinkage and associated stress:**

The polymerization shrinkage and flexural strength of resin based materials vary according to their curing efficiency when placed in large-increment thickness. Shrinkage can cause stress in the tooth, the bonding layer and within the composite 22.

The degree of polymerization shrinkage is directly related to the composite characteristics such as matrix type, filler content, polymerization kinetics, degree of conversion, and modulus of elasticity 22-24. Therefore, to change the characteristic of a new material this formulation has to be modified.

The matrix of resin based material is mainly bis-GMA but in addition to that some companies added a blend of higher molecular weight urethane dimethacrylate (UDMA) and bisphenol A polyethylene glycol diether dimethacrylate (Bis-EMA) instead of the lower molecular weight triethylene glycol dimethacrylate (TEGDMA) to increase the viscosity of the material 11-13, 22. The filler content and size influence

composite shrinkage as well and therefore, for the bulk fill materials the use of higher nano-filler volume reduced significantly the polymerization shrinkage 23.

Another area of concern is the physico-mechanical properties of these materials and whether they are maintained in the whole thickness of the bulk cured material. An in vitro shear bond strength test that has been done in primary and permanent teeth found that the performance of the bulk fill materials in shear bond stress tests appear to be similar and even slightly better than the conventional nanohybrid composites 15. The top-bottom hardness measurement has also been tested in one study and they found a direct relationship between shrinkage stress, flexural modulus and hardness and therefore, in the tested bulk fill materials the ones that exhibit low shrinkage stress are characterized by low hardness and flexural moduli 23, 24.

**Conclusions:**

Bulk Fill restorative materials offer reduced placement time and technique sensitivity. This means fewer possibilities of contamination or trapping bubbles as sometimes happens with incremental placement of composites 3. The manufacturers' claims for an increased depth of cure appear to be confirmed. Similarly, the polymerization shrinkage stress appears to be similar with conventional composites in most of the studies reviewed.

Given the lack of long term randomized controlled clinical trials that would definitely be needed to support the use of these materials, it appears that the goals set by the manufacturers are achieved and these materials can be incorporated in the clinical practice with caution, especially in cavities with high C-factor.

**CLINICAL RELEVANCE:**

Although Bulk fill resin based composites are generally more translucent, the practitioner has to follow the manufacturer's recommendations on curing time and maximum incremental thickness.

Minimum irradiation time of 10s stated by the manufacturers cannot be recommended for the placement of high viscosity bulk fill materials in 4mm increments neither for flowable type. Keeping in mind that materials cannot be over-cured, these materials should be cured for at least 40s to achieve better results.

There is only one clinical trial with a three year follow up and all other studies revealed in our literature search were in vitro 25. There is definitely a need for more trials before conventional sculptable composites are totally replaced by the bulk fill materials.

**Case 1**

A 38 years old female, presented to the restorative clinic for a permanent filling after root canal treatment was (Photo 1). The patient's medical history is clear and no allergies, no medication and no smoking history are reported. radiographic examination revealed a satisfactory root canal treatment that was completed 3 week earlier. After placement of rubber dam and removal of the temporary filling in tooth #15, the cavity depth was measured periodontal probe and found to be 8 mm deep. The guttapercha was reduced 2 mm apically from the canal orifice and a modified glass ionomer cement (Vitrebond Light Cure Glass Ionomer Base, 3M ESPE, Seefeld, Germany) was applied floor of the pulp chamber and cured for 20 seconds (Photo 2). A tofflemire matrix was placed and burnished to achieve a contact with the adjacent tooth (Photo 3). The next step was etching of enamel and dentin with 37% phosphoric acid for 30 seconds and rinsing with copious amounts of water for 10 seconds, followed by application of a layer of adhesive resin single bond, 3M ESPE, Seefeld, Germany). Flowable bulk fill material (SDR, Dentsply International Inc, York, PA, USA) applied in 2 layers 4mm and 3mm thick and cured for 40 seconds each (Photo 4). Finally a layer of conventional (Filtek Z350, shade A2, 3M ESPE, Seefeld, Germany) was applied as a capping layer and cured for 40 seconds. and polishing was done using finishing diamonds and rubber cups (Photo 5).



Photo 1: Defective temporary restoration that needs to be replaced with a permanent filling, before a full coverage restoration is fabricated for tooth # 15



Photo 2: After the old restorative material is removed, resin modified glass ionomer cement was placed to seal the root canal access cavity.



Photo 3: The matrix band is carefully burnished towards the adjacent tooth

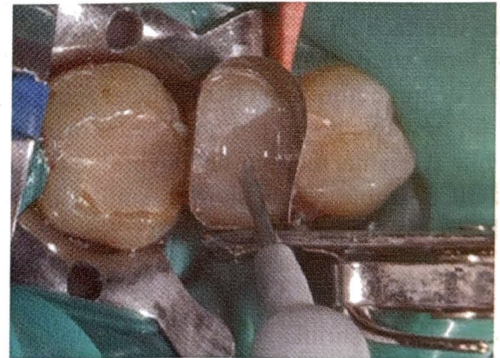


Photo 4: Bulk fill flowable composite is placed in two layers (4 + 3mm) in the cavity



Photo 5: The restoration after placing a final layer of conventional composite, finishing and polishing

**Case 2**

A 20 year old female patient, presented to the dental clinic with a fractured restoration in tooth #46 (Photo 6). The patient's medical history is free of pathologies, no allergies, no medication and no smoking history are reported. After rubber dam placement, the old composite filling was removed (Photo 7). The cavity was etched with 37% phosphoric acid for 30 seconds and rinsed with water for 10 seconds. The adhesive was applied (Adper single bond, 3M ESPE, Seefeld, Germany) and cured for 20 seconds. After that it was restored with a bulk fill sculptable composite (Tetric Evo Ceram Bulk Fill, Ivoclar Vivadent, Schaan, Lichstenstein), placed in one increment (Photo 8). The occlusion was checked and adjusted and finishing diamonds and rubber points were used to finish the procedure (Photo 9).



Photo 6: Broken composite restoration on tooth #47



Photo 7: The cavity preparation after removal of the old restoration

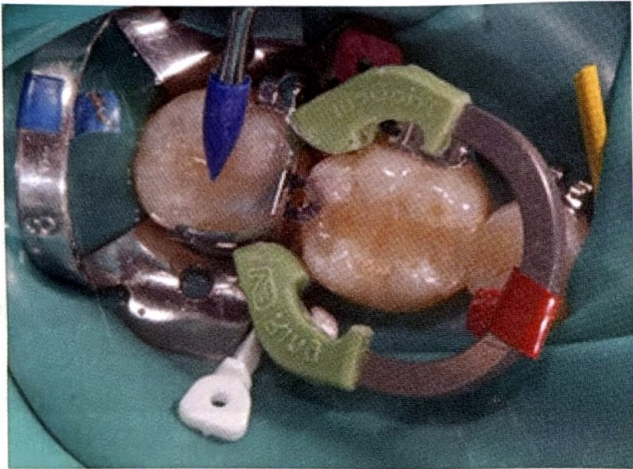


Photo 8: Bulk Fill sculptable composite is placed in one increment as the cavity was not deeper than 4mm.

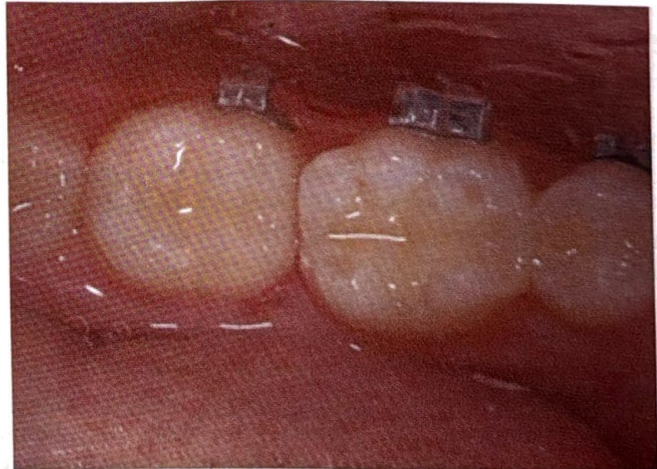


Photo 9: The Mesial-Occlusal bulk fill composite restoration after finishing and polishing

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