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Bulkfill flowable composite resins – A review

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Abstract
Flowable composite resins are widely used in clinical practice. Bulk Fill flowable resins with improved mechanical and chemical characteristics have recently been introduced. These composites are low-viscosity materials with the reduced percentage of inorganic filler particles and higher amount of resinous components. Consequently, the polymerization process leads to volumetric contraction, but with minimal stress contraction. Flowable composites, with their low elastic modulus compete with stress development, potentially helping to maintain the marginal seal of the restoration. The flowable composites are readily workable and adaptable to cavity walls and their use can reduce marginal defects in restorations. This review enlighten various aspects of bulkfill flowable composite resin materials.

Keywords: Composite, Flowable, Resin, Bulkfill, Incremental, Polymerization

Introduction

Direct composite restorations in the posterior dentition have become an indispensable element of modern dentistry. The performance of these restoration, even in the masticatory load-bearing posterior region, has been conclusively proven in many clinical studies. This procedure is usually carreid out in an elaborate layering technique. This time-consuming procedure requires an economically sensible fee, corresponding to the effort involved. Aside from the possibilies that highly aesthetic composites offer in the application of polychromatic multiple-layer techniques, there is also a great market demand for the most simple and quick and therefore economical composite-based materials for posterior teeth. These products are offered in the category of bulk-fill composite.

Composite resins are considered material of choice in restorative dentistry because of the increasing demand for high-quality esthetic results in everyday practice. They have been widely used in the restoration of posterior teeth due to increasing demand for esthetics as well as dramatic improvement in newer generation bonding agents and resin composite formulations. The currently available nanocomposite restorative systems are suitable for both anterior and posterior restorations as they provide adequate resistance in high stress bearing areas and superior esthetics than microhybrids. Nevertheless, despite the continuous evolution of these resins, problems such as polymerization shrinkage and marginal microleakage still occur [1]. Polymerization of dimethacrylate resin composites and formation of a cross-linked polymer bring a volumetric shrinkage of 1.5–6 vol%. Stresses from shrinkage create forces that compete with the adhesive bond, and this may disrupt the bond to cavity walls, which is still one of the main causes of marginal failure and subsequent microleakage [2]. This volumetric shrinkage results in marginal leakage especially in dentin margins of restorations. Furthermore, with high-viscosity composite resin, it is difficult to obtain perfect adaptation to the internal cavity surface and proper marginal seal of the cavity. Many attempts have been made to decrease microleakage of adhesive restorations, such as development of new resin monomers and filler systems, incremental filling technique, type of light source, light and curing mode and changes in C-factor and direction of polymerization shrinkage. The restorative techniques that reduce the level of stress due to resin composite polymerization shrinkage have been suggested.

Flowable composite resins are widely used in clinical practice and are the most common resin materials that are recommended for restoring these lesions instead of conventional resin composites.

Bulk Fill flowable resins with improved mechanical and chemical characteristics have recently been introduced [3]. Flowable resin composites are low-viscosity materials with the reduced percentage of inorganic filler particles (44-55% in volume) and higher amount of resinous components. Consequently, the polymerization process leads to volumetric contraction, but with minimal stress contraction. According to Hooke's Law, stress is determined by volumetric shrinkage and the elastic modulus of the material [1]. Flowablecomposites, with their low elastic modulus compete with stress development, potentially helping to maintain the marginal seal of the restoration. Moreover, flowable composites are readily workable and adaptable to cavity walls and their use can reduce marginal defects in restorations. These materials have good aesthetic properties [4]. The material is marketed as a resin composite for bulk application in direct composite resin restorations.

SDR (Smart Dentin Replacement) Posterior Bulk Fill Flowable Base is a single component, fluoride containing, and visibly light cured radiopaque resin composite restorative material. The composition is as follows: barium aluminofluoroborosilicate glass, strontium aluminofluorosilicate glass, modified urethane dimethacrylate resin, ethoxylatedbisphenol Adimethacrylate (EBPADMA), triethylene glycol dimethacrylate (TEGDMA), camphorquinonephotoinitiator, butylatedhydroxytoluene (BHT), UV stabilizer, titanium dioxide, and iron oxide pigments. It has handling characteristics typical of a flowable composite but can be placed in 4 mm increments with minimal polymerization stress. SDR has a self-leveling feature that allows intimate adaptation to the prepared cavity walls [5]. Available in one universal shade, it is designed to be overlaid with a methacrylate based universal/posterior composite for replacing missing occlusal/facial enamel [5].

Sonic Fill system consists of a KaVo tip providing sonic application of a bulk-fill type composite by Kerr. Shrinkage stress compensation mechanism in Sonic Fill system was obtained using a resin having low shrinkage properties and high around 84% filler content [6]. Other components are glass, oxide, chemicals (10–30%), 3-trimethoxysilylpropyl methacrylate (10–30%), silicon dioxide (5–10%), ethoxylatedbisphenol A dimethacrylate (1–5%), bisphenol A bis (2-hydroxy-3-methacryloxypropyl) ether (1–5%), and triethylene glycol dimethacrylate (1–5%). It is indicated for use as a bulk fill posterior composite resto- rations and can be bulk filled in layers up to 5 mm in depth due to reduced polymerization shrinkage. Sonic- FillTM incorporates a highly-filled proprietary resin with special modifiers that react to sonic energy. As sonic energy is applied through the hand piece, the modifier causes the viscosity to drop (up to 87%), increasing the flow ability of the composite enabling quick placement and precise adaptation to the cavity walls. When the sonic energy is stopped, the composite returns to a more viscous, non-slumping state that is perfect for carving and contouring. The photoinitiators in the composite material allow a full 5 mm depth of cure in 20 seconds with a 550mW/cm2 light source.

Tetric Evo Ceram Bulk Fill (Ivoclar Vivadent) is a nanohybrid composite with a monomer matrix containing dimethacrylates (20-21% weight). The fillers contain barium glass, ytterbium trifluoride, mixed oxide, and prepolymer (78%–81% by weight). Additional contents are additives, catalysts, stabilizers, and pigments (<1.0% weight). The total content of inorganic fillers is 76-77% weight or 53-54% volume [7]. The particle size of the inorganic fillers is between 40 nm and 3,000 nm with a mean particle size of 550 nm. Tetric Evo Ceram Bulk Fill contains in its composition an inhibitor of sensitivity to light and thus provides prolonged time for modeling of filling, an inhibitor of shrinkage stress in order to achieve optimal marginal seal, and Ivocerin, polymerization photoinitiator allowing curing of 4 mm layers of material.

Filtek Bulk Fill (3M ESPE), a low-viscosity, visible-light activated flowable material for filling with bulk-fill technique, is manufactured in four shades (each of which may be polymerized in 4 mm increments according to international ISO standards) and two kinds of packaging, capsules and syringes. It contains Bis-GMA, UDMA, Bis-EMA, and Procrylat resins [8]. Fillers are a combination of zirconia and silica having a particle size of 0.01–4.5 microns and ytterbium trifluoride filler having a particle size of 0.1–5.0 microns. The inorganic filler loading is approximately 64.5% by weight (42.5% by volume).

X-tra base flowable posterior bulk base composite cure 4mm in 10 sec, saves time, low shrinkage stress allows bulk fill speed, High strength makes it suitable for openand closed sandwich technique, Smart self-leveling properties for excellent wall adaptation without slumping out of maxillary restorations, High radiopacity (350% Al) for easy x-ray identification, Available in patented non-dripping NDT syringes, or unit dose caps with extra long bendable needle tip, Available in shades A2 and Universal [9].

Bulk fill composite resins are further classified into high-viscosity and low-viscosity (flowable) materials. High-viscosity bulk fill composites include greater amounts of filler particles compared to low-viscosity bulk fill composites. As a result, the flowable composite resins exhibit better adaptation on the cavity walls but present greater polymerization shrinkage and lower mechanical properties [10]. Due to their lower mechanical properties their restorations is recommended to be finished with a 2-mm capping layer of a high-viscosity bulk fill composite resin, especially when restoring areas which are submitted to occlusal stresses.

It has been demonstrated that preheated composite resins show reduced viscosity and increased polymerization efficiency. Heating composite resins prior to placement in the cavity and immediately light-curing increases monomer conversion rate and thus the duration of the irradiation period may be decreased. With increased paste temperature, free radicals and developing polymer chains become more fluid as a result of reduced paste viscosity and they react to a greater extent, leading to a more complete polymerization reaction and enhanced cross-linking. The increase in the degree of polymerization of composite resins may lead to better internal adaptation to cavity walls, improved mechanical properties and increased wear resistance.

The newly developed bulk-fill resins offer composites including low-viscosity (flowable) and high-viscosity (sculptable) material types. Bulk-fill composites are more translucent than other restorations, which allow the light to get to much deeper layers. The content of photoinitiators of polymerization and stress inhibitors determines the optimal marginal seal of these composites. The bulkfillflowable composite resin possess a lower modulus of elasticity, as well as lower levels of polymerization stress in comparison to traditional flowable composite, without compromising on depth of cure.

The main advancements of bulk-fill materials, namely increased depth of cure, which probably results from higher translucency and low shrinkage stress are related to modifications in the filler content and/or the organic matrix [11]. ideally, these perceived improvements should not be at detriment to the mechanical properties of the material. Recent studies have reported that bulk-fill resin composites exhibited acceptable levels of creep resistance, in the range shown by conventional material types, although some bulk materials investigated (SDR and Venus Bulk Fill) presented a significantly higher creep strain than the nanohybrid composite Filtek Supreme XT (3M-ESPE). Among flowable composites (Esthet X Flow, Dentsply; Filtek Supreme Plus Flow, 3M-ESPE), SDR exhibited the lowest Vickers hardness, the highest elastic modulus and the highest creep, but all three properties were much lower than hybrid composites (Filtek Silorane, 3M-ESPE; EsthetX Plus, Dentsply; Filtek Supreme Plus, 3M-ESPE).Similarly, another study raised some concerns regarding low to very low hardness and elastic modulus for some bulk-fill materials, especially SDR, Venus Bulk Fill and Filtek Bulk-Fill.22 In other work, some improvement in elastic modulus, flexural strength and greater increase in fracture toughness were attributed to a bulk-fill material containing glass microfibers (Xenius, GC) compared with bulk-fill types.

Resin-composite material is its ease of use. In addition, flowable resin-composites facilitate superior handling and ease for placing direct restorations. The main advantages of these materials are:

- high wettability of the tooth surface, ensuring penetration into every irregularity;
- ability to form layers of minimum thickness, so improving or eliminating air entrapment;
- high flexibility, so less likely to be displaced in stress concentration areas;
- radiopaqueness and
- Availability in different colors.

In conclusion, bulk fill composite materials may be very useful for restorations of posterior teeth mainly due to their advantages in application technique and polymerization shrinkage. However, further studies especially *in vivo* are necessary to verify the improved clinical performance of bulk fill composite resins.

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