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Review Article

One Bulk Fill Composite Restorative Material: Advantages and Application Technique

Muhannad Saleh Aljunayh[1], Abdullah Ghazi Alharbi[1], Abdulrahman Omar Aldosari[1], Mutaz Mohammed Alghamdi[1], Nasser Mushabbab Alqahtani[1] and Ahmed Mohamed Elmarakby[2]*

[1]General Practitioner Dentist, Ministry of Health, KSA

[2]Assistant Professor and Chairman of the Department of Restorative Dental Sciences, AlFarabi Colleges for Dentistry and Nursing, Riyadh, KSA and Lecture of Department of Operative Dentistry, Faculty of Dental Medicine, Al-Azhar University, Assiute Branch, Egypt

***Corresponding Author**: Ahmed Mohamed Elmarakby, Assistant Professor and Chairman of the Department of Restorative Dental Sciences, AlFarabi Colleges for Dentistry and Nursing, Riyadh, KSA and Lecture of Department of Operative Dentistry, Faculty of Dental Medicine, Al-Azhar University, Assiute Branch, Egypt.

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Abstract

Objective: The current review article was directed to shed light on the current classification and application technique of One Bulk Fill Composite Restorative material.

Methodology: The following electronic databases will be searched: The Cochrane Oral Health Group Trials Register, Central Register of Controlled Trials, MEDLINE, EMBASE and PubMed. There will be no restrictions regarding language or date of publication. We also intend to search the reference lists of articles and contacted experts and organizations to identify any further studies.

Selection criteria: The inclusion criteria of this study will be: Randomized control clinical trial, cohort studies, surveys, or case control studies, ADA regulations and recommendations for Bulk Fill Composite Restorative material use. On the contrary, the exclusion criteria will be: studies older than 1995, non-blinded clinical trials, studies reporting the failure of Bulk Fill Composite Restorative material because these interventions are evaluated in separate reviews.

Results: 60 research articles have been obtained related to the subject. After application of exclusion criteria, only 16 research articles are accepted.

Conclusion: Knowledge and awareness of dental practitioners regarding compositions, classifications, indications and contraindications of Bulk Fill Composite Restorative material play an important role in success or failure of material selection and proper handling.

Keywords: *Bulk Fill Composite Restorative Material; Mesio-Occlusodistal (MOD); Tetric EvoCeram Bulk Fill (TBF)*

Introduction

Composition and benefits

Bulk-filling techniques have become more widely used following the development of materials with improved curing [1,2], controlled polymerization contraction stresses [3,4] and reduced cuspal deflection [5]. Using this approach, the number of increments required to fill a cavity is reduced in comparison with traditional incremental filling techniques. In contrast to the maximum 2-mm increments recommended for conventional resin composites, manufacturers recommend 4- or 5-mm increments of the bulk-fill resin composites. The use of the bulk-fill technique undoubtedly simplifies the restorative procedure and saves clinical time in cases of deep, wide cavities. However, the data available for these materials are currently limited [6] and therefore further laboratory studies are required in order to provide insight into likely clinical outcomes. The use of thicker increments in bulk-fill resin composites is due to both developments in photoinitiator dynamics and their increased translucency [7], which allows additional light penetration and a deeper cure [8,9]. Other than the improved depth of cure, recently developed bulk-fill resin composites exhibit lower polymerization contraction stress and contraction rates than hybrid and flowable resin composites [3]. However, a higher modulus of elasticity and increased plastic deformation suggest that the interfacial stress accumulation generated when using these bulk-fill materials, as well as the resulting consequences such as cuspal deflection and marginal gaps, may be difficult to predict [3]. Gap formation may result from excessive contraction stresses at the interface between the restoration and the tooth [5,10,11] which can be a consequence of the polymerization rate of the material [12] and the magnitude of polymerization contraction [11,13]. Additionally, contraction stresses are influenced by the composition and filler content of the resin composite [1,13,14] its elastic modulus [12,15] and its ability to flow, and thus compensate for the stresses generated during polymerization [11-13,16]. The degree of conversion [12,13,17] as well as depth of cure [18] of the material are also likely to influence the development of stresses, which may affect the quality of the bond at the interface of restorations. In materials with increased polymerization contraction, the interfacial stresses are more likely to be higher than can be compensated for by relaxation of the material [16] and cuspal deflection [5,19,20]. If these interfacial stresses exceed those that can be supported by the adhesive layer, gap formation will occur [21-23] thus compromising the adhesive reinforcement of the tooth structure. Additionally, if the resin composite has limited depth of cure, it is likely to generate less contraction stress around the cavity walls and margins, thus possibly disguising an improved marginal adaptation due to poor polymerization. The complexity of interaction between some of these factors [1,13,15] may be further aggravated in cavities with an increased C-factor [24,25] or in the deeper and wider cavities, which are often encountered in the occlusal and approximal surfaces of posterior teeth. Earlier research has demonstrated lower cuspal deflection after restoration of mesio-occlusodistal (MOD) cavities with two bulk-fill materials when compared with a nanohybrid resin composite [5]. This corroborates the previously reported findings of lower polymerization contraction stresses for a bulk-fill resin composite [3]. Finally, under fatigue testing, similar marginal integrity was observed in MOD cavities restored with one type of bulk-fill material and conventional resin composites [26]. Despite the positive results reported from previous studies, bulkfill resin composites are somewhat recent materials with varied composition and handling characteristics, and thus have different physical properties [2,3,6,27-30].

Polymerization shrinkage issue

Composite materials first appeared in dentistry in the 1960s with Bowen's discovery of Bis-GMA matrix. Since then, their composition significantly improved, leading to better esthetics, mechanical properties and clinical durability [31]. The greatest disadvantages of conventional composite materials are stress that occurs as a result of polymerization shrinkage and depth of cure limited to approximately 2 mm. In order to overcome these issues, it is recommended to use oblique incremental technique for composite application, by using 2-mm thick layers [32]. However, the incremental technique can also negatively affect the final outcome of the restoration due to contamination between increments, a weaker bond between layers, and time consumption [33]. The bulk-fill composite resins emerged from the necessity to reduce clinical working time for direct composite restorations while simultaneously keeping a satisfactory degree of conversion and reducing polymerization shrinkage. The biggest advantage of these materials is the possibility of application in 4-mm thick layers [34]. Low-shrinkage composites were developed to tackle the issue of polymerization shrinkage but their success was limited, mainly because the clinical benefit was not always clear; no apparent differences in outcome were found [35] and layering was still required due to the limited depth of cure [36]. In addition, composites based on new low-shrinkage monomer technology [37] were often less practical to use due to the requirement of a specific bonding system [38]. Meanwhile, the demand for a true amalgam alternative kept on increasing, due in part to the more comprehensive ban on products containing mercury and the global amalgam "phase-down" program instituted by the WHO [39,40]. Ideally, such an amalgam alternative would be an easy-to-use, forgiving material. In this respect, the possibility of filling a cavity in bulk has some attractive benefits; above all, the procedure takes less time and the "window of opportunity" for technical errors, such as void incorporation and contamination between layers, can be decreased. Concerning this quality, reinforced glass-ionomers cements (GICs; e.g. Equia Forte, GC [Tokyo, Japan]; ChemFil Rock, Dentsply [Konstanz, Germany]) have been marketed as well. Just like amalgam, these GICs can be placed in bulk and the use of a separate adhesive is obviated. However, like chemically curing composites, they lack the great advantage of light curing [41], which increases the working time and thus facilitates controlled restoration placement to a great extent. A dual-curing UDMA- based material categorized as "alkasite" (Cention N, Ivoclar Vivadent; Schaan, Liechtenstein), which claims to contain alkaline glass fillers capable of releasing substantial levels of fluoride, has also been recently proposed for bulk placement in retentive preparations without the application of an adhesive. Ideally, the material would be self-adhering, to avoid the use of an adhesive or an invasive retentive cavity design. Today, experimental versions of self-adhering bulk- fill composites are being developed in an attempt to meet these demands. However, several criteria must be met before a composite is truly suitable for bulk filling. Besides the increased depth of cure and effective handling of polymerization shrinkage issues, the composite should have sufficient wear and fracture resistance to avoid early failures and should possess acceptable dimensional stability. It seems unlikely that all required properties can be optimized in one ideal material, since improvements in one property will often be made at the expense of another; several key properties are influenced by the same variable, so that compromises are nearly inevitable. This most likely explains the large differences in properties seen with existing bulk-fill composites. Moreover, due to large compositional variations, which are generally not completely disclosed by the manufacturer, a proper classification of composition-related properties based on the commercially available materials is impractical [23].

Types and categories

Two groups of bulk-fill composites can be distinguished: (a) low-viscosity materials which are used as base materials and require an additional capping layer and (b) high-viscosity materials which are sole cavity filling materials. In conventional composite resins, light attenuation due to light reflection from the material surface, scattering from filler particles and absorption by photoinitiators are limiting the depth of cure to approximately 2 mm. Among other factors, filler content and particle size are critical to dispersion of light beam [43]. In contrast to the trend of reducing the filler particle size and producing nano composites, fillers in bulk-fill composites are in the macrofiller range, in order to increase translucency of the material and increase the depth of cure [44]. Larger filler particles have lower filler surface area and thus smaller resin-filler interface, which is responsible for the majority of light scattering. Some low-viscosity bulk-fills also have reduced filler content. Besides these modifications, the possibility of 4-mm composite application for Tetric EvoCeram Bulk Fill is a result of the additional germanium-based photoinitiator Ivocerin [45]. The depth of cure as established by the ISO 4049 method seems to be overestimated for bulk-fill composites. Instead, it is recommended to use Vickers microhardness measurements at the surface and specific depths for determination of the depth of cure [46]. Additionally, the microhardness data for a specific material provide information on its wear, polishability and abrasive effect on antagonist teeth. Positive correlation was found between volume fraction of fillers and Knoop hardness [47], as well as between mass fraction of fillers and Vickers microhardness [48]. Regarding the size of fillers, the composites containing nanofillers were found to exhibit higher microhardness values than conventional composites due to more intimate contact of nanofillers with resin matrix than microfillers [48].

Biocompatibility/cytotoxicity

The cytotoxicity of composite resins in restorative procedures has been associated with the quantity and type of residual monomer released, and studies have shown a correlation between this phenomenon and mass loss and/or low degree of conversion [49]. Thus, composite resins, known as bulk-fill resins, with modifications in their chemical formulation and polymerization properties, have been developed to minimize or eliminate polymerization shrinkage, increasing the depth of polymerization as well as cytotoxicity. Bulk-fill resins with a 4 - 6 mm single increment have low shrinkage stress and a high degree of polymerization at this depth, due in particular to the increase in translucency and to the presence of polymerization modulators [50]. However, what is not clear is whether the degree of conversion at this depth is compromised, which would increase the cytotoxic potential, especially in the case of bulk-fill flowable resins with a higher organic matter content [51].

How to overcome shrinkage?

For sufficient polymerization, three vital characteristics are essential for the light-curing unit: Adequate light output, appropriate wavelength range of the light, and exposure time [52]. Other factors affect the depth of cure, including RC type, shade and translucency, increment thickness, distance from the tip of the light-curing unit, postirradiation period [53] and size and distribution of filler particles [9]. A number of approaches can be employed to place composite resins into a cavity. Some researchers recommend the use of an incremental technique, through which the material is gradually placed in layers of 2 mm or less [54]. This approach to restoring teeth has a number of advantages; for example, it results in better light penetration and better polymerization of the composite resin [55], reduces the cavity configuration factor [56] reduces cuspal deflection [57] reduces polymerization shrinkage stresses, and ensures that the resin adheres better to cavity walls [17,20]. However, in addition to these advantages, there are a number of disadvantages associated with the use of an incremental approach to placing resin; for example, voids can be trapped between the increments [58] bonding failures may occur between the increments, it can be difficult to place composite material after conservative cavity preparation, and the time taken to complete the procedure is more lengthily due to the time required to place and polymerize each increment [22]. In an effort to overcome many of the downsides associated with an incremental approach to placing resin, a number of new restorative materials have emerged that are marketed as “bulk fill” composites. However, clinicians who have become accustomed to the incremental cure philosophy when placing light-cured composites, quite rightly question what specifically has changed to make these “bulk fill” light cured composites a viable alternative [33]. While bulk fill composites represent an attempt to speed up the restoration process by allowing dentists to place composite material in increments of 4 or 5 mm thickness [59] Tetric EvoCeram bulk fill (TBF) contains in its composition an inhibitor of sensitivity to light and thus provides prolonged time for modeling of filling, an inhibitor of shrinkage stress to achieve optimal marginal seal and Ivocerin, polymerization photoinitiator allowing curing of 4 mm layers of material. According to the manufacturer’s information, this new composite will achieve full depth bulk fill up to 4 mm without a superficial capping layer, unlike the bulk fill flowable. The manufacturer states thatTBF contains a shrinkage stress reliever to minimize polymerization shrinkage; this is a modified unique filler partially functionalized with silanes. While numerous laboratory studies have explored the depth of cure [29], marginal adaptation [21,27], shear-bond strength [30], internal adaptation [31], microhardness, degree of conversion [60], cuspal deflection [16], polymerization contraction [29,33-35] and light irradiation potential [36] of bulk fill materials, clinical data are hard to find. To date, just two studies [61]. Bulk-fill resin composites are advised to be used in larger increments without compromising the degree of conversion (up to 4 mm according to some manufacturers). Concerns with the polymerization of large increments relies on the polymerization shrinkage and on the stresses generated in the tooth/restoration interface [62]. Promising results have been reported with these materials, mainly due to lower polymerization shrinkage [63] which also depends on the composite organic/inorganic matrix composition and properties such as viscosity and elastic modulus. Although several materials with different viscosities and handling characteristics are commonly classified as bulk-fill resin composites, their properties can change considerably, especially due to modifications in the organic matrix, with the incorporation of monomers with higher molecular weight, as well as changes in filler content and incorporation of stress relievers [64]. Composites can be subdivided according to their consistency in low- and high-viscosity. Higher shrinkage stress for flowable composites are expected since they generally have a higher organic content when compared to microhybrid and nanoparticulate composites, which can result in greater polymerization shrinkage and lower mechanical properties [24]. Similarly, a lower Young’s modulus may allow stress dissipation during the polymerization process, thus reducing the stress when bigger increments are used [26]. Given this discussion, the viscoelastic behavior (and its development during the polymerization process) and the volumetric shrinkage are critical during the generation of polymerization stress, showing the importance of stress development among composites with different viscosities [65].

Conclusion:

1. Polymerization shrinkage remains a challenge, and one of the leading causes of secondary caries around resin-based composites (RBCs), which is the primary season for the clinical replacement of RBCs.
2. Research has focused on improving placement techniques, materials, and composite formulation, primarily the material's polymetric matrix, to develop systems with reduced polymerization shrinkage and polymerization shrinkage stress.
3. The latest generations of flowable composites, i.e. bulk-fill flowable composites, have higher filler content and claim to have improved mechanical properties, making them preferred for larger posterior restorations.
4. Knowledge and awareness of dental practitioners regarding compositions, classifications, indications and contraindications of Bulk Fill Composite Restorative material play an important role in success or failure of material selection and proper handling.

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