Bulk-Fill Composites

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The indications to use composites as a minimally invasive restorative in the posterior region have increased considerably in the latest years. While not so long ago, composites were considered unsuitable to restore extensive lesions in the posterior, load-bearing area, new clinical evidence shows favorable outcomes for cusp-replacing restorations in posterior composites [1]. These findings are especially important in light of the phasedown of the use of amalgam [2], which calls for new treatment alternatives in these clinical situations. With the increasing use of composites in extreme indications, convenience and simplicity of these materials have become increasingly important.

Classically, a restoration is placed in increments that are cured separately. The limited depth of cure of conventional composites, usually no more than 2 or 2.5 mm, has precluded the use of thicker layers. Another reason to opt for an incremental technique is to reduce the polymerization shrinkage stress [3–5], although this argument has also been contradicted [6–8]. Low-shrinkage composites were developed to manage shrinkage-induced stress, but layering was still required due to the limited depth of cure [9].

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Bulk-filling, as opposed to the incremental technique, obviously offers attractive benefits, since the latter can be very time-consuming, especially in large cavities. Moreover, the risk of including voids or gaps between the consecutive layers can be avoided. However, several criteria should be met before a composite is truly eligible for bulk-filling. The restorative must be able to be polymerized at the full depth of the restoration. Shrinkage stress should be reduced to a minimum. Meanwhile, the handling properties should enable the placement of composite without the inclusion of air and voids. Finally, the composite must have sufficient resistance to fracture and wear to endure the occlusal forces in the posterior region.

8.1 Classification and Composition

Although bulk-fill is a rather recent term for composites that can be placed without the necessity of using an incremental technique, the concept is not new; composites with similar properties already existed on the market before the introduction of this terminology with the launch of SDR posterior flowable base (Dentsply; Surefil SDR flow in America). The depth of cure of Quixfil (Dentsply), a high-viscosity posterior restorative from the same company, is also claimed to be 4 mm. Moreover, some light-cured core buildup materials (e.g., Clearfil Photo Core,

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Kuraray) are also claimed to be suitable for bulk placement with a depth of cure beyond 4 mm.

Usually, bulk-fill composites are divided in high-viscosity [10] and flowable [11] composites. The flowable composites usually require an additional capping layer, while the high-viscosity composites do not [12, 13].

An outsider in this classification is SonicFill 2 (Kerr) (the successor of SonicFill, Kerr), which has a high viscosity that decreases considerably when the material is sonicated [14] and thus does not strictly belong to either of the groups.

It has been pointed out in the scientific literature that differences between individual composites are more distinct than differences between bulk-fill and conventional composites [15].

Hence, it is not surprising that their chemical composition is not particularly different from other conventional composites. Some composites have unique constituents. Tetric EvoCeram Bulk Fill (Ivoclar Vivadent) contains a patented germanium-based photoinitiator, called Ivocerin [16], which has a higher potency than the traditional photoinitiator camphorquinone, albeit at lower peak wavelength. A patented urethane-based methacrylate resin incorporating a photoactive group is included in SDR (Dentsply) to alter the radical polymerization process [17].

8.2 Clinical Evidence

Since bulk-fill composites are a rather new class, no long-term studies are available at the moment. Some results on the medium term have been published by Manhart et al. [18] on Quixfill and by Van Dijken et al. [19] on SDR. Those studies show that in a period of up to 5 years, those two bulk-fill composites do not perform significantly different from conventional composite restorations in the posterior, load-bearing area. However, this does not mean that those results can be extrapolated to other bulk-fill materials, as their properties vary widely. No randomized controlled clinical trials exist for any of the high-viscosity composites. More controlled clinical trials that exclusively focus on extensive (comprising a wide isthmus or replacing at least one cusp), deep restorations are necessary to elucidate whether they are truly suitable for these indications. The currently available evidence is clearly not substantial enough to make definitive conclusions.

8.3 Laboratory Properties

When a considerable volume of composite is placed in load-bearing areas, good mechanical properties are required. Extensive studies have been conducted comparing the flexural strength of several flowable and high-viscosity bulk-fill composites [13, 20–22]. Overall, the high-viscosity bulk-fill composites have better mechanical properties such as flexural strength and fracture toughness than their flowable counterparts; however, variations between the individual products are so large that it would be ill-considered to make general conclusions. When looking at the individual products, we find that some flowable bulk-fill composites consistently show better strength than some of the high-viscosity bulk-fill composites [13, 20–22]. On the other hand, wear resistance will be less relevant for the flowable bulk-fill composites, since the manufacturers instruct to cap them with a conventional composite [12, 13, 15].

Another thought that deserves consideration is that the finally constituted polymer network of the composite and its properties are not entirely homogeneous. What mostly seems to distinguish bulk-fill composites from other conventional composites is the claim that their depth of cure is increased to 4 mm or beyond. In the literature, there are large variations in the measured depth of cure of bulk-fill composites [21, 23–34], which can easily be explained by the differences in setup. Besides the fact that the depth of cure is not only dependent of the restorative but also on the used light source, irradiation parameters, and the timing of the measurements, there is no consensus on how an acceptable depth of cure should be established. Several methods have been used, such as microhardness measurements and degree of conversion. However, maximum hardness and degree of conversion that can be obtained are dependent on the composition of the composites and, even so, do not reflect the quality of the polymer network *per se* [35, 36]. Hence, it becomes rather difficult to claim an absolute depth as the depth of cure. Nevertheless, some observations can be made. Irradiance of composites will inevitably drop with decreasing depth because of attenuation due to absorption, scattering, and reflection [35]. Hence, the better light at wavelengths absorbed by the used initiators (camphorquinone has a peak absorbance around 468 nm [37] and the germanium-based Ivocerin around 408 nm [32], respectively) can pass (lower attenuation coefficient); the closer the quality of the cured resin will be in the deeper layers. Indeed, it has been confirmed that bulk-fill materials are more translucent [28, 38–40] than conventional composites. The flowable bulk-fill composites tend to be more translucent than the high-viscosity composites. As a result, they also tend to cure faster [33]. This increased translucency might result in esthetical compromises, although the more translucent flowable variants are masked by their capping layer. Another observation is that short curing times might not be sufficient to reach optimum levels of conversion in deeper layers, which once again confirms that the "exposure reciprocity law" is not absolute [41–43]. Shorter exposure to a higher irradiance renders inferior mechanical properties in depth when compared to a longer exposure to lower irradiance [10, 11, 32].

While the volumetric shrinkage of the high-viscosity bulk-fill composites is comparable with that of conventional posterior composites, with reported values around 2%, shrinkage of the flowable bulk-fill composites tends to be somewhat higher, around 3% [25, 44].

8.4 Adaptation, Shrinkage Stress, and Handling

Ideally, a restoration should seal the cavity outline perfectly without the occurrence of gaps. There are two main causes for the occurrence of gaps and voids in a restoration that are caused by the restorative rather than the adhesive: air inclusion during insertion due to the handling properties [45] and gaps arising due to shrinkage of the material [25, 46]. Unlike amalgam, composites are not condensable materials. Handling is quite subjective and has not been widely studied in the literature. The viscosity of the bulk-fill materials is similar to conventional high-viscosity and flowable composites for both classes, respectively. However, it has been reported that it is difficult to achieve intimate adaptation with high-viscosity composites [45, 47], while with flowable composites, it is more difficult to achieve a tight proximal contact with the adjacent tooth [48].

In the ongoing research regarding shrinkage stress of bulk-fill composites, despite a multitude of publications [21, 49–51], results remain largely contradicting and inconclusive. One of the main reasons is that shrinkage stress is not a material property but depends largely on the compliance and the configuration of the cavity [52] as well as the development of the properties over time [53]. Most studies report lower shrinkage stress with bulk-fill composites when compared to conventional composites [21, 49, 54, 55], but differences found between the flowable and high-viscosity bulk-fill composites vary largely. Moreover, apart from some conflicting reports on cuspal strain [12, 56–58], the stress measurements do not take the application technique (single increment vs. multiple increments) into account.

Conclusion

While the mechanical properties of bulk-fill composites vary largely between the individual products, they are, in general, comparable to conventional composites. The main distinctive feature of bulk-fill composites is increased translucency and consequently increased depth of cure. In the short term, the use of bulk-fill composites renders clinical results that are comparable with conventional composite placement. However, since few products have been tested in clinical trials, it is too early to draw general conclusions.

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