Flowable and Regular Bulk-Fill Composites: A Comprehensive Report on Restorative Treatment

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This article reports a comprehensive restorative treatment using bulk-fill composites and discusses their properties and clinical performance. A 20-year-old man sought dental treatment due to the dark shade of his smile and multiple old amalgam fillings. Based on clinical and radiographic findings, and the patient’s demand for tooth-colored fillings, treatment comprised enamel microabrasion and in-office dental bleaching, followed by the replacement of amalgam fillings by bulk-fill composites. Bulk-fill composites exhibit modifications in the filler size and shape or in the chemistry of monomers that allow them to be applied in thicker layers (4 to 5 mm), creating opportunities for simpler, faster, and more-efficient clinical procedures, as seen in the present report.


Resin composites exhibit limitations related to shrinkage stresses induced by their polymerization process, which might result in clinical complications.1,2 In order to reduce these issues, low-shrinkage resin-based materials were developed for bulk placement, known as bulk-fill composites. Bulk-fill composites tend to present lower polymerization-induced stress, enabling clinicians to perform direct posterior restorations with a single 4- to 5-mm-thick layer of composite (depending on manufacturers’ recommendations) instead of incremental layering. Therefore, restorative procedures become faster and less technique-sensitive, which raises interest amongst clinicians.3

Despite recent advancements regarding bulk-fill composites, scientific literature still lacks clinical case reports focused on describing detailed restorative approaches that benefit from bulk placement. This case report presents multiple posterior direct restorations using both flowable and regular bulk-fill composites. The clinical protocol is illustrated by showing a step-by-step sequence of posterior fillings using three different techniques. Important aspects about the properties of bulk-fill materials are also discussed throughout this article.
Case Description and Results

Case Presentation

A 20-year-old male patient came to the Graduation Clinic at Piracicaba Dental School with a chief complaint related to the dark, yellowish aspect of his smile, and he wanted to replace old amalgam fillings with an esthetic material. After initial exams, intraoral photographs were taken (Fig 1), as well as interproximal and periapical radiographs. Amalgam fillings were present in almost all molars except both mandibular second molars. These amalgams showed clear signs of oxidation, marginal deterioration, and inadequate anatomy (Figs 1b and 1c), although no secondary caries were revealed by radiographic exam. The mandibular right first molar had a complex atypical amalgam restoration fractured at the occlusal surface. The mandibular left second molar had been provisionally sealed with glass-ionomer cement. Anterior teeth showed an intense yellow shade with discoloration spots suggestive of mild fluorosis, and inactive white lesions at the buccal-cervical region of both maxillary canines. Malocclusion was also observed, probably due to the inappropriate positioning of posterior mandibular teeth, leading to a slight anterior open bite. Furthermore, agenesis of the maxillary lateral incisors was reported by the patient.

The treatment plan consisted of enamel microabrasion coupled with dental bleaching, followed by the replacement of all amalgam fillings with bulk-fill composites—as the patient demanded tooth-colored restorations—and reconstruction of the mandibular left second molar with a composite onlay. A list of all the materials used is shown in Table 1. After restorative procedures, orthodontic treatment was carried out; only after solving malocclusion issues were esthetic restorative procedures performed to alter the shape of maxillary canines, which had taken the place of the missing maxillary lateral incisors.
Esthetic, Nonrestorative Procedures

After the patient had been submitted to supragingival dental scaling and prophylaxis, a single session of microabrasion was performed using a slurry of chemical and mechanical abrasives (Opalustre, Ultradent). This procedure improved tooth color and enamel surface smoothness. After 1 week, three sessions of in-office bleaching with 35% hydrogen peroxide (Whiteness HP Maxx, FGM) were performed, leading to a shade lighter than B1 (Fig 2).

Restorative Treatment

Restorative procedures were initiated 15 days after dental bleaching. Posterior teeth, except pre-molars and mandibular second molars, had their amalgam fillings replaced by bulk-fill composites. Hereafter, three step-by-step sequences describe the bulk-filling techniques used:

Flowable Bulk-Fill Covered by Conventional Composite (Two-Step Amalgam-Like Sculpting Technique)
The initial aspect of the maxillary right first molar is shown in Fig 3a, where a Class II (mesial-occlusal-palatal) amalgam filling with marginal breakdown at the palatal surface, extensive oxidation, and unsatisfactory anatomy is observed. The patient was anesthetized, and the operatory field was isolated with a rubber dam. Removal of the amalgam filling was carried out with round diamond burs (1014HL and 1016HL, KG Sorensen) in a high-speed handpiece under water-cooling. The final cavity preparation is presented in Fig 3b. A metal matrix band, assembled with a wedge, was adapted around the tooth prior to adhesive application. A two-step, self-etch adhesive system (Clearfil SE Bond, Kuraray), coupled with selective enamel etching (35% phosphoric acid for 30 seconds; Ultra-Etch, Ultradent) was applied and light cured (30 J/cm²; VALO, Ultradent) following the manufacturer’s recommendations. The palatal and mesial surfaces were restored with a conventional composite (Filtek Z350 XT, shade A2E, 3M ESPE) using the layering technique to transform the previous Class II into a Class I cavity so application of the flowable bulk-fill composite would be facilitated. Cavity depth was measured to be 5 and 3 mm at the palatal and mesial surfaces, respectively. Three millimeters of a flowable bulk-fill composite (X-tra Base, U shade, VOCO) were applied at the base of the cavity (Fig 3c) and light cured for 20 seconds.

Table 1 Materials Used in the Clinical Case

<table>
<thead>
<tr>
<th>Material (manufacturer)</th>
<th>Composition</th>
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<tbody>
<tr>
<td>Opalustre (Ultradent)</td>
<td>6.6% hydrochloric acid, silicon carbide</td>
</tr>
<tr>
<td>Whiteness HP Maxx (FGM)</td>
<td>35% hydrogen peroxide, thickener, dye mixture, glycol, inorganic filler, and deionized water</td>
</tr>
<tr>
<td>Ultra-Etch (Ultradent)</td>
<td>35% phosphoric acid, cobalt aluminate blue spinel, siloxane</td>
</tr>
<tr>
<td>Clearfil SE Bond (Kuraray)</td>
<td>Primer: HEMA, 10-MDP, hydrophilic aliphatic dimethacrylate, dl-camphorquinone, accelerators, water, dyes Bond: Bis-GMA, HEMA, 10-MDP, hydrophilic aliphatic dimethacrylate, colloidal silica, dl-camphorquinone, initiators, accelerators, others</td>
</tr>
<tr>
<td>Filtek Z350 XT, shade A2E (3M ESPE)</td>
<td>Bis-GMA, Bis-EMA, UDMA, TEGDMA, polyethylene glycol dimethacrylate, silane treated ceramic, silane treated silica, silane treated zirconia, BHT</td>
</tr>
<tr>
<td>X-tra Base, U shade (VOCO)</td>
<td>Bis-EMA, aliphatic dimethacrylate, silica</td>
</tr>
<tr>
<td>X-tra Fil, U shade (VOCO)</td>
<td>Bis-GMA, UDMA, TEGDMA, silica, glass oxide</td>
</tr>
<tr>
<td>Admira Fusion X-tra, U shade (VOCO)</td>
<td>Organically modified silicic acid, Ba-Al-Si-glass, silica nanoparticles</td>
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HEMA = 2-hydroxyethyl methacrylate; 10-MDP = 10-methacryloyloxydecyl dihydrogen phosphate; Bis-GMA = bisphenol A diglycidylmethacrylate; Bis-EMA = bisphenol A polyethylene glycol diether dimethacrylate; UDMA = urethane dimethacrylate; TEGDMA = triethylene glycol dimethacrylate; BHT = 2,6-di-tert-butyl-p-cresol.
This material presented a highly translucent aspect after curing. The remaining depth of the cavity was filled with the same conventional composite, recovering tooth anatomy and protecting the flowable material from potential wear caused by occlusal loading and toothbrushing. The final restoration after finishing and polishing is shown in Fig 3d.

Packable/Regular Bulk-Fill Composite (One-Step Amalgam-Like Sculpting Technique)

Another technique, suitable for smaller restorations such as occlusal Class I caries lesions, is based on the use of a high-viscosity, paste-like (or packable) bulk-fill composite without prior placement of any base/liner material. This approach was indicated for the mandibular left second molar (Fig 4a), which, in this case, acts as the first molar; the patient lost the first molar at a young age, and the second molar moved mesially.

Rubber-dam isolation, cavity preparation, and adhesive system application were performed as in the previous technique (Fig 4b). The only difference was that the cavity was totally filled by a single layer of a regular bulk-fill composite (X-tra Fil, U shade, VOCO) that was sculptured with specific spatulas (Suprafill #½ and #1, SSWhite Duflex), similarly to an amalgam filling (Fig 4c). Figure 4d shows the result after finishing and polishing.

Flowable Bulk-Fill Covered by Regular Bulk-Fill Composite (Adaptation of the Two-Step Amalgam-Like Sculpting Technique)

The mandibular right first molar had a large amalgam filling with intense wear and occlusal fracture (Fig 5a). All procedures prior to composite filling placement were performed exactly as described for the maxillary right first molar. After removing all amalgam (Fig 5b), the lack of remaining hard tissues forced the treatment to be redefined to a full-crown rehabilitation. However, as the patient would still undergo orthodontic treatment, a reconstruction with bulk-fill composites was chosen, and after orthodontic therapy, the tooth will receive a full-ceramic crown. The following technique describes the use of bulk-fill composites to build up a core for crown support.
A 4-mm–thick flowable bulk-fill composite (X-tra Base, U shade, VOCO) was applied at the base of the cavity to ensure optimal adaptation at the gingival walls and internal angles (Fig 5c). One concern regarding this material is that it might slip to the distal portion of the cavity, leaving no space for coverage with regular composite. Thereby, it is mandatory to use a spatula before light curing to make sure the material is uniformly distributed. After application of flowable composite, the restoration was covered with a single layer of a packable bulk-fill composite (Admira Fusion X-tra, U shade, VOCO) (Fig 5d). The reconstruction of a molar by the traditional layering technique would involve multiple layers of composite, which is time-consuming. After removing the metal matrix band, adding another composite layer to the buccal surface was necessary to improve anatomy. Regular bulk-fill composites have a technical drawback regarding adequate packing: as a high amount of composite is placed at once, defects may occur due to the difficulty in adapting this material to marginal walls. Figure 5e shows the final reconstruction after finishing and polishing.

Final Aspect

Remaining amalgam restorations were replaced according to the techniques described above, and the mandibular left third molar (acting as the mandibular left second molar) received a composite onlay. The result of the treatment can be seen in Fig 6. The patient is currently under orthodontic treatment and...
is expected to return for a full-crown rehabilitation of the mandibular right first molar and re-anatomization of the maxillary canines.

Discussion

In addition to aromatic and/or aliphatic dimethacrylate-based monomers, bulk-fill composites exhibit modified monomers (mostly not fully disclosed by manufacturers) with the aim of reducing shrinkage stresses during light curing. Moreover, some bulk-fill composites might also present modifications in their initiator system, allowing more efficient curing. Other composites also have smaller filler concentration, which renders the material more translucent and enables light to pass through deeper layers (4 to 5 mm), providing a more uniform monomer conversion.

The correct use and handling of light-curing units (LCUs) should not be neglected. Price et al (2015) suggest if a composite is not submitted to sufficient radiant exposure, it will not fulfill the physical properties or bond strength intended by manufacturers, which could lead to bulk fracture, secondary caries, or marginal breakdown. This is relevant for Class II fillings, since the margins of interproximal caries lesions are highly susceptible to secondary caries. Recent publications evaluating LCU parameters advise the following: wavelengths delivered by LCUs should match the photoinitiators in the materials used; LCUs should be recharged often and cooled down between uses; the light tip should be kept parallel and close to the composite surface; and tip size should correspond to the whole composite surface—otherwise, multiple photo-activations should be done.

Flowable bulk-fill composites present a mechanical disadvantage compared to conventional or packable bulk-fill composites. Therefore, the coverage of the flowable-base material with a high viscosity composite has been suggested. On the other hand, packable bulk-fill composites present satisfactory fracture strength, flexural modulus, and marginal adaptation compared to conventional composites. The so called “two-step amalgam-like sculpting technique” and an adaptation of it were applied in this case report (maxillary right first and mandibular
right molars). Another approach was adopted to restore the mandibular left second molar. The tooth was filled with a single layer of a regular, high-viscosity bulk-fill composite using the “one-step amalgam-like sculpting technique” without any base material. Application of a high-viscosity material over a flowable bulk-fill base has been suggested to significantly increase fracture strength when compared to conventional composites combined with the layering technique. Moreover, a 3-year clinical trial of posterior restorations showed similar performances between the flowable bulk-fill with conventional composite technique and the layering approach.

In a recent study, restorations made with X-tra Base (VOCO) were evaluated for 3 years by the Modified United States Public Health Service criteria. A 4-mm thickness of bulk-fill composite was applied with a 2-mm occlusal coverage using a conventional composite (GrandioSO, VOCO) in Class II caries lesions of endodontically treated teeth. Acceptable clinical performance was observed compared to the layering technique, since 100% of the fillings with X-tra Base scored as “bravo” after 3 years. Conversely, higher wear resistance and hardness were reported for X-tra Base, and this material has the highest filler ratio (61 vol%) compared to other flowable bulk-fill composites, according to a literature review.

Supporting manufacturers’ recommendations for covering flowable bulk-fill composites, studies in the literature described a decrease in surface microhardness of two flowable bulk-fill materials after storage in food-simulating solvents. Additionally, similar in vitro biomechanical behavior of regular bulk-fill composites compared to conventional materials has been reported. The X-tra Fil composite contains higher filler content and larger fillers compared to other regular bulk-fill composites. These features give X-tra Fil high flexural strength and microhardness, making it suitable to be placed in load-bearing posterior regions. Moreover, studies have shown X-tra Fil can be properly cured in bulks up to 4 mm thick.

Admira Fusion X-tra (VOCO) is a bulk-fill material based on Ormocers (Organically Modified Ceramics), which are hybrid polymers with a siloxane network selectively modified by organic groups (polysiloxanes with light-curable methacrylates covalently bonded to silica). The larger size of these molecules should reduce polymerization shrinkage, wear, and leaching of monomers. According to the manufacturer, Admira Fusion X-tra represents a new generation of Ormocer-based composites that reduces volume shrinkage to an extremely low level (1.25%), with very low shrinkage stress (3.87 MPa), which results in many advantages compared to other bulk-fill composites, such as higher surface hardness, adequate biocompatibility, and color stability. As far as the authors know, a study to confirm these properties is not available yet.

Admira Fusion X-tra showed lower cuspal deflection and cervical microleakage than conventional composites or its first-generation, non–bulk-fill counterpart (Admira Fusion). Conversely, a systematic review and meta-analysis involving Ormocer materials showed worse clinical behavior compared to conventional composites, particularly after long-term aging. However, the fact that only first-generation Ormocers were included in this review must be considered, as recent developments, such as dimethacrylate-diluent-free Ormocer matrices were introduced in the market.

Conclusions

Bulk-fill resin-based materials can be efficiently used in different clinical protocols to restore esthetics and function, or as intermediary fillings to support indirect restorations, reducing technique complexity and chairside time. The use of Ormocer bulk-fill composites is also an option, but clinicians must be aware there is a shortage of scientific evidence regarding the clinical performance and potential advantages of the newer generations of Ormocer-based materials.

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