Restoration of large-volume defects using a thermoviscous bulk-fill composite material – a clinical case report

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Summary:

Today, direct composites restorations in posterior teeth are a very successful part of the therapy spectrum in state-of-the-art restorative dentistry. The positive performance of this treatment method in the masticatory load-bearing posterior region has been documented in numerous clinical studies. These restorations are usually placed in an elaborate incremental layering technique. However, there is a great market demand for the most simple and quick and therefore economical to place bulk-fill composite materials for posterior teeth. A new development in this class of materials is a bulk-fill composite with thermally controlled viscosity behavior.

Keywords

Bulk-fill composite, thermoviscous composite, composite, direct restorations, posterior teeth, adhesive technique

1. Introduction

In recent years, the indications for direct resin-based composite restorations were continuously expanded due to improvements in the technology of composite materials and related adhesive systems, as well as an optimization of clinical treatment protocols in adhesive dentistry [1-14]. Today, direct resin bonded composites are becoming first choice for many dental practitioners for the restoration of posterior defects, even extensive cavities in load-bearing areas are considered suitable for the direct adhesive technique [9, 12, 15-17].

To date, incremental layering is considered to be the gold standard for placing light-curing composite materials [18]. Generally, conventional composites are placed in individual layers of maximum 2 mm thickness due to their particular polymerization properties and limited depth of cure. Each increment is polymerized separately for 10 to 40 s, depending on the light intensity of the curing device used, the shade and translucency level of the respective composite paste and the type and concentration of the photoinitiator system of the composite material [19]. Thicker layers of these conventional composites, however, do not polymerize properly and therefore produce poor mechanical and biological properties [20-22].

Especially in the case of large-volume posterior cavities, the conventional incremental technique can be a very time-consuming and complicated, technology-sensitive procedure [23]. That is why many dentists are looking for an alternative to this complex multi-layer placement technique, so that direct composites can be processed in less time and thus more economically and at the same time with greater product safety [24-27]. The bulk-fill composites have been developed in recent years in response to this growing demand for more efficiency. Using a simplified application protocol these materials can be placed into cavities in increments of 4 to 5 mm thickness with short polymerization times of 10 to 20 s per increment when a high-intensity curing-light is engaged [19, 24, 28-31].

Bulk-fill composites are usually offered in two versions that require completely different application techniques:

1. Low-viscosity, flowable bulk-fill composites, which flow well onto the cavity floor and the cavity walls and optimally wet the interior line and point angles of the preparations. These flowable bulk-fill composites must be protected on the occlusal surface by an additional capping layer (2 mm thickness) made of a regular hybrid composite which is qualified for load-bearing posterior restorations [23, 32, 33], since the flowable bulk-fill composites have a reduced filler content and contain comparatively large fillers in order to lower polymerization stress. As a result, however, they have poorer mechanical and aesthetic properties compared with conventional hybrid composites: for example a lower modulus of elasticity, a reduced wear resistance, an increased surface roughness and an inferior polishability [19, 34-38]. In addition, the capping layer allows to create the functional contouring of occlusal anatomical structures, as this would be very difficult or even impossible to manage with a flowable composite material.

2. Regular to high-viscosity, sculptable bulk-fill composites that can reach up to the occlusal surface and do not require an additional protective capping layer. Thus, no additional composite material is required.

Bulk-fill composite materials in both viscosity versions allow a single layer thickness of 4 to 5 mm due to optimized depth of cure. This means that the high-viscosity bulk-fill composites can be used in a single-layer technique in a cavity which depth corresponds at most to the depth of cure of the material. If deeper defects are to be restored or if the flowable bulk-fill composite variants are used, this always requires a two-phase procedure with an additional composite layer. Technically, the present bulk-fill composites that are available for the simplified restoration of posterior teeth are not really bulk-fill materials, because in particular many proximal cavities extend into areas that are deeper than the maximum curing depth of these materials (4 to 5 mm) [39, 40].

A new approach is taken by the thermoviscous bulk-fill composite VisCalor bulk (VOCO, Cuxhaven). This is a high-viscosity composite material at room and body temperature, which is converted to a flowable consistency by heating to a temperature of 68 °C in a composite oven or a special dispenser with heating function (Thermo-Viscous-Technology). In the heated phase, the material flows perfectly onto the cavity walls. Even in narrow and undercut areas of the defect as well as in internal line and point angles, an excellent wetting is observed, and thus facilitates the application of the restorative material into the cavity. VisCalor bulk again reaches body temperature within a short time when it comes to tooth contact and thus returns to the high-viscosity, sculptable state. VisCalor bulk thus combines the flowability of a low-viscosity composite during application with the sculpting ability of a high-viscosity composite within one single restorative composite material. Since the entire cavity can be filled with the same composite material, there is also a time saving compared to combined systems of flowable and sculptable composite materials. VisCalor bulk can be manipulated in layers up to 4 mm thickness. It is available in 4 shades (universal shade, A1, A2, A3). It exhibits a polymerization shrinkage of 1.44 vol.-% with simultaneously low shrinkage stress (4.6 MPa). With a flexural strength of 164 MPa, the material shows a high mechanical stability. VisCalor bulk ensures good color stability and stable mechanical properties thanks to low water absorption. The application compule is headed by a narrow, flexible cannula, which perfectly enables direct application of the thermoviscous composite to hard-to-reach and narrow cavity areas.

2. Clinical Case Presentation

A 59-year old female patient requested in our dental office the replacement of her amalgam restoration in a maxillary first right molar (Fig. 1).

Fig. 1: Preoperative situation: old amalgam filling in a maxillary first right molar (photo taken using an intraoral mirror).

During the clinical inspection, the tooth reacted sensitively in the cold test and showed no negative reaction to the percussion test. In consultation with the patient and after an explanation of the possible restorative alternatives and treatment fees, the patient decided on a direct bulk-fill restoration using VisCalor bulk (VOCO GmbH, Cuxhaven).

Treatment started with thoroughly cleaning the affected tooth of external deposits using a fluoride-free prophylaxis paste and a rubber cup. Shade determination was done on the moist tooth prior to the application of rubber dam. After administration of local anesthetics, the old amalgam restoration was carefully removed while conserving the remaining hard tissues (Fig. 2).

Fig. 2: Situation after careful removal of the old restoration.

After excavation, the cavity was completely prepared and finished with a fine-grit diamond bur (Fig. 3).

Fig. 3: After excavation of carious tooth tisue, the cavity preparation was finished using fine-grit diamond burs.

The tooth was subsequently isolated with rubber dam (Fig. 4).

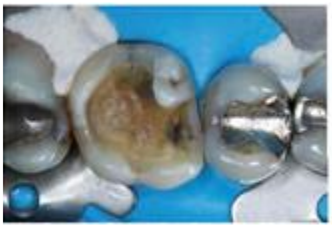

Fig. 4: Isolation of the operating field using rubber dam.

A metal matrix was used to delimit the cavity (Fig. 5).

Fig. 5: Placement of a sectional matrix system.

The universal adhesive Futurabond M+ (VOCO) was chosen for the adhesive pretreatment of the dental hard tissue. Futurabond M+ is a state-of-the-art universal one-bottle adhesive that is compatible with all common conditioning techniques and adhesive strategies currently in use (multimode adhesive): the self-etch technique without the use of phosphoric acid and both phosphoric acid-based "etch-and-rinse"-conditioning techniques (selective enamel etching with phosphoric acid or complete total-etch pretreatment of enamel and dentin with phosphoric acid). Also in these universal adhesives, the preliminary conditioning of enamel using phosphoric acid (selective enamel etching) results in better adhesion promotion [41-43]. Unlike former traditional self-etch adhesives, the new universal adhesives are insensitive to phosphoric acid etching of dentin [44-48]. The possibility of being able to vary the application protocol at short notice when using these universal adhesives without changing the adhesion promoter reduces the technique sensitivity and gives the necessary freedom to the dentist to react flexibly to different clinical situations (e.g. dentin close to the pulp, risk of bleeding of the adjacent gingiva, etc.).

In this clinical case, the total-etch adhesive pretreatment using phosphoric acid was used. 35% phosphoric acid (Vococid, VOCO GmbH, Cuxhaven) was applied along the enamel margins first for a reaction time of 15 s (Fig. 6),

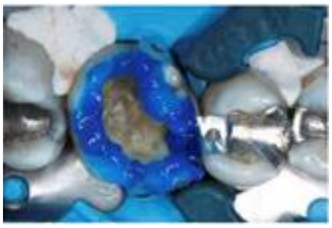

Fig. 6: Conditioning of enamel with 35% phosphoric acid.

followed by an additional conditioning of the dentin for further 15 s (Fig. 7).

Fig. 7: After 15 s, the phosphoric acid was additionally applied onto the dentin and acts there for a further 15 s.

Subsequently the cavity was washed thoroughly for 20 s with the air-water-spray to remove the acid and precipitation residues. The cavity was then gently air-dried from excessive moisture avoiding desiccation of the dentin (Fig. 8).

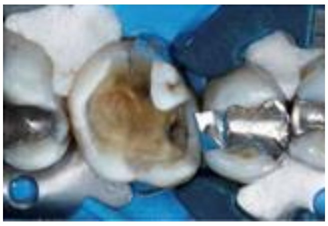

Fig. 8: Situation after thoroughly rinsing the conditioning agent and gentle air-drying the cavity avoiding desiccation of the dentin.

Ample amounts of the adhesive Futurabond M+ were applied and distributed generously in the area of the cavity using a microbrush (Fig. 9).

Fig. 9: Adhesive pretreatment of the dental tissues with the universal adhesive Futurabond M+.

It must be ensured that all cavity areas are sufficiently covered by the adhesive. After at least 20 seconds of carefully scrubbing the adhesive into the tooth surface, the solvent was carefully evaporated with dry, oil-free compressed air from the bonding agent until a glossy, immobile adhesive film resulted (Fig. 10).

Fig. 10: Careful evaporation of the solvent from the adhesive with compressed air.

Then, the bonding agent was subsequently light-cured for 10 seconds (Fig. 11).

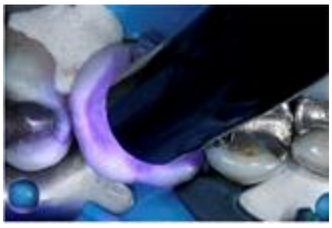

Fig. 11: Light polymerization of the bonding agent for 10 s.

The result was a shiny cavity surface, evenly covered with adhesive (Fig. 12).

Fig. 12: A shiny cavity surface means evenly sealing dentin and enamel with adhesive.

This should be carefully checked before placing the restorative material, as any areas of the cavity that appear matte are an indication that insufficient amount of adhesive has been applied to those sites. In the worst case, this could result in reduced bond strength of the restoration to these areas and, at the same time, in inadequate dentin sealing, which may lead to persistent postoperative sensitivity in vital teeth. This complication, which often requires the replacement of a newly-made bonded dental restoration, can usually be avoided by a careful adhesive protocol. If such dull-looking areas, not or inferior covered by adhesive, are detected in the visual inspection, additional bonding agent is selectively applied to them to optimize the adhesive layer.

The thermoviscous composite VisCalor bulk (VOCO, Cuxhaven) was heated in a composite oven (Caps Warmer, VOCO, Cuxhaven) at 68 °C (Fig. 13).

Fig. 13: The thermoviscous composite VisCalor bulk (VOCO, Cuxhaven) was heated in a composite oven (Caps Warmer, VOCO, Cuxhaven) at 68 °C.

The narrow, flexible cannula of the VisCalor bulk compule facilitates direct application of the composite even in hard-to-reach areas and narrow cavity areas (Fig. 14).

Fig. 14: The narrow, flexible cannula of the VisCalor bulk compule facilitates direct application of the composite even in hard-to-reach areas and narrow cavity areas.

The cavity was filled up to half of the defect height with the first increment (maximum layer thickness: 4 mm). The low-viscosity consistency in the heated state results in excellent adaptation behavior of the bulk-fill composite onto the cavity walls (Figs. 15 and 16).

Fig. 15: The cavity was filled up to half of the defect height with the first increment of the heated composite VisCalor bulk (maximum layer thickness: 4 mm).

Fig. 16: The low-viscosity consistency in the heated state of VisCalor bulk resulted in excellent adaptation behavior of the bulk-fill composite onto the cavity walls.

The first composite layer was subsequently polymerized for 20 s with a high-performance curing light (light intensity > 1.000 mW/cm^2) (Fig. 17).

Fig. 17: Light polymerization of the restorative material for 20 s (light intensity > 1.000 mW/cm^2).

With the next increment of VisCalor bulk the remaining cavity volume (maximum layer thickness: 4 mm) was completely filled using the bulk-fill technique (Fig. 18).

Fig. 18: With the next increment of VisCalor bulk the remaining cavity volume (maximum layer thickness: 4 mm) was completely filled using the bulk-fill technique.

The second layer of composite material was again light-polymerized for 20 s (Fig. 19).

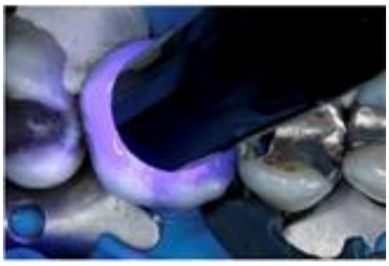

Fig. 19: Light polymerization of the restorative material for 20 s (light intensity > 1.000 mW/cm²).

After removal of the metal matrix band, the restoration was checked for imperfections (Fig. 20).

Fig. 20: After removal of the metal matrix band, the restoration was checked for imperfections.

Additional 10 s light curing cycles from mesio-lingual (Fig. 21)

Fig. 21: Additional 10 s light curing cycle from mesio-lingual direction in the region of the gingival seat of the proximal box.

and mesio-buccal (Fig. 22)

Fig. 22: Additional 10 s light curing cycle from mesio-buccal direction in the region of the gingival seat of the proximal box.

direction in the region of the proximal box, especially at the gingival seat, were executed to ensure that all areas covered before by the metal matrix band experienced sufficient polymerization.

After removal of rubber dam, the fissure relief and the fossae of the occlusal anatomy were finished with a pear-shaped fine-grit diamond bur. In the next step of the standard finishing sequence, a point-shaped fine-grit diamond was then used to finish the convexity of the cusps and triangular ridges. After the elimination of occlusal interferences and adjustment of the static and dynamic occlusion, the accessible proximal areas were contoured and prepolished with abrasive disks. The use of diamond-impregnated composite polishers (Dimanto, VOCO, Cuxhaven) achieved a satin matte, lustrous finish on the surface of the restoration. Subsequent high-gloss polishing was completed using the same Dimanto polishers with reduced pressure to optimize the luster of the restorative material. Figure 23 shows the completed direct bulk-fill composite restoration, reconstructing the original tooth shape with an anatomical and functional occlusal surface, physiological formed proximal contact area, and an excellent esthetic appearance.

Fig. 23: Final result: the direct VisCalor bulk composite restoration blends in well to the surrounding hard dental tissue.

To complete the treatment, a fluoride varnish (Bifluorid 12, VOCO, Cuxhaven) was applied to the affected tooth using a foam pellet.

3. Conclusion

Composite-based direct restorative materials will still gain in importance in the years to come. These restorations present a scientifically proved, high-quality permanent treatment option for the masticatory load-bearing posterior region and their reliability has been documented in literature [11, 49-55]. The results of a comprehensive review have shown that the annual failure rates of direct posterior composite restorations (2.2%) are not statistically different to amalgam restorations (3.0%) [51].

The growing economic pressure on the health care system and, in many cases, a lack of financial means on the part of patients with regard to additional payments adequate to services are creating a need for reliable, easy-to-use and faster-to-complete and therefore more economical basic posterior restorative treatment options as an alternative to the time-consuming high-end solutions [26]. In addition to the universal hybrid composites, which are available in various shades and levels of opacity, new bulk-fill composites with optimized depth of cure have lately emerged on the market. They are specially designed for use in posterior dentition, where they produce esthetically pleasing restorations. The placement procedure is economically more efficient than that of conventional hybrid composites [56, 57]. Supplementary to low-viscosity and high-viscosity bulk-fill composite materials, the material options in the sector of light-activated direct placement restoratives with increased curing depth were recently expanded by a bulk-fill composite with thermally controlled viscosity behavior.

BIOGRAPHY

Dr. Manhart is Professor, Department of Restorative Dentistry, Dental School of LMU-University in Munich, Germany. He offers seminars and practical hands-on workshops in esthetic restorative dentistry, such as direct composite restorations, all-ceramic restorations, veneers, post-endodontic treatment, management of severely worn dentition, and treatment planning in esthetic dentistry. He can be reached via e-mail at manhart@manhart.com

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