

Cusp replacement with an extensive posterior direct restoration using a nanohybrid bulk-fill ormocer

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Supplementary to bulk-fill composites based on traditional methacrylate chemistry, material options have recently been expanded by a nanohybrid ormocer version, demonstrates.

Today, direct composite restorations in posterior teeth are a part of the standard therapy spectrum in modern dentistry. The performance of this treatment method in the masticatory load-bearing posterior region has been conclusively proven in many clinical studies, even for extensive composite restorations with cuspal coverage.

These restorations are usually carried out in an elaborate incremental layering technique. Aside from the possibilities 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 it is therefore economical to place bulk-fill composite materials for posterior teeth.

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 optimisation of clinical treatment protocols in adhesive dentistry (Wolff et al, 2015; Hickel et al, 2004; Frese et al, 2014a; Frese et al, 2014b; Frese et al, 2014c; Frese et al, 2013; Roggendorf et al, 2012; Manhart and Hickel, 2014; Lynch et al, 2014; Staehle, 2007; Staehle, 1999; Heintze and Rousson, 2012; Deliperi and Bardwell, 2006a).

Today, direct resin-bonded composites are becoming the 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 (Lynch et al, 2014; Deliperi and Bardwell, 2006a; Demarco et al, 2012; Scholtanus and Ozcan, 2014; Laegreid et al, 2014). The maximum preservation of hard tooth tissues using direct composites as an alternative to indirect onlays and partial crowns is one of the major advantages and key elements when restoring severely damaged teeth with cuspal involvement (Hickel et al, 2004; Lynch et al, 2014; Plotino et al, 2008; Denehy and Cobb, 2014; Brackett et al, 2007; Fennis et al, 2004; Segura and Riggins, 1999; Macpherson and Smith, 1994; Mondelli et al, 2013; Kois et al, 2013; Kantardzic et al, 2012; Xie et al, 2012; Elayouti et al, 2011; Kuijs et al, 2006).

The replacement of single cusps with direct composite restorations is meanwhile an accepted treatment method and scientifically proven (Hickel et al, 2005). However,

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Figure 1: Initial situation: insufficient composite restoration with cuspal involvement in a first lower molar



Figure 2: Situation after removal of the old restoration, cavity preparation, application of rubber dam and matrix placement



Figure 3: Adhesive pretreatment of the dental tissues with the universal adhesive Futurabond U (self-fetch)



Figure 4: Careful evaporation of the solvent of the adhesive



Figure 5: Light curing of the bonding agent for 10 seconds



Figure 6: A shiny cavity surface means evenly sealing dentin and enamel with adhesive

when the replacement of three or four cusps is needed in very large defects, indirect restorations – requiring additional substance removal in many cases – are still the preferred option for most dentists (Lynch et al, 2014; Laegreid et al, 2014). Longevity studies on posterior composite restorations including cusp replacement show an acceptable performance and qualify this treatment option as an alternative to conventional indirect restorations in selected clinical cases (Scholtanus and Ozcan, 2014; Laegreid et al, 2012; Deliperi and Bardwell, 2006b; Opdam et al, 2008; Fennis et al, 2014).

To date, incremental layering is considered to be the gold

standard for placing light-curing composite materials (Park et al, 2008). Generally, conventional composites are placed in individual layers of maximum 2mm thickness, due to their particular polymerisation properties and limited depth of cure. Each increment is polymerised separately for 10-40 seconds, depending on the light intensity of the curing device used and the shade and translucency level of the respective composite paste (Ilie and Stawarczyk, 2014).

Thicker layers of these conventional composites, however, do not polymerise properly and therefore produce poor mechanical and biological properties (Tauböck, 2013; Ferracane and Greener, 1986; Caughman et al, 1991).



Figure 7: Shaping of the distal proximal area with a small amount of Admira Fusion x-tra and a special hand instrument. Light polymerisation of the restorative material for 20 seconds



Figure 8: After polymerisation, a cervical composite bridge stabilises the matrix in the distal contact area



Figure 9: The next increment Admira Fusion x-tra completes the distal proximal wall and forms the outer contour of the distolingual cusp



Figure 10: Situation after removal of the metal matrix



Figure 11: The next increment Admira Fusion x-tra brings the remaining cavity depth to a maximum of 4mm



Figure 12: The last layer Admira Fusion x-tra was used to completely fill the cavity

The conventional increment technique can be a very time-consuming and complicated procedure when it is used to restore large and voluminous cavities in posterior teeth.

However, many dentists eagerly wish for an alternative to this highly technique sensitive multiple-layer technique, in order to be able to process posterior composite restorations in less time and therefore more economically (Manhart, 2011; Burtscher, 2011). 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 4-5mm thickness with short polymerisation times of 10-20 seconds per increment when a high-intensity curing-light is engaged (Ilie and Stawarczyk, 2014; Manhart, 2011; Czasch and Ilie, 2013; Finan et al, 2013; Manhart, 2010).

Bulk-fill materials

'Bulk fill' means that a cavity can be filled completely in a single step according to state-of-the-art restorative techniques, without having to place multiple layers (Hickel,



Figure 13: View after sculpting the occlusal surface



Figure 14: Polymerisation of the occlusal composite layer for 20 seconds

2012). To date, the only direct filling materials available for this type of application have been cements and chemically or dual-curing core build-up composites. Nevertheless, cements (glass ionomer cements and derivatives, as well as other cement restoratives) are currently not suitable for placing clinically durable permanent restorations in load-bearing posterior cavities, since their mechanical properties are inadequate for this indication (increased risk of fracture or wear in the areas affected by masticatory loads).

Therefore, cements should only be used for intermediate restorations/long-term temporaries (Hickel et al, 2005; Frankenberger, et al, 2009; Lohbauer, 2010; Burke and Lucarott, 2009; Scholtanus and Huysmans, 2007). Moreover, core build-up composites are not approved for use as restorative materials and they are not suitable for this purpose due to their specific handling properties (eg, lack of sculptability for the design of the occlusal surface anatomy).

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 (4-5mm) (Frankenberger et al, 2012a; Frankenberger et al, 2012b). Nonetheless, if suitable composites are used, cavities with a depth of up to 8mm – which includes most of the defects seen on a daily basis in dental clinics – can be restored with two increments.

Most dental restorative composite materials contain organic monomer matrices based on traditional methacrylate chemistry, such as bisphenol A dimethacrylate (Bis-GMA) and its derivatives urethane dimethacrylate (UDMA) and triethylene glycol dimethacrylate (TEGDMA) as being the most often used diluent monomer (Peutzfeldt, 1997). Alternative chemical formulations use silorane resins

(Guggenberger and Weinmann, 2000; Weinmann et al, 2005; Lien and Vandewalle, 2010; Ilie and Hickel, 2006; Ilie and Hickel, 2009; Zimmerli et al, 2010) and ormocers (Manhart et al, 1999a; Wolter and Storch, 1992; Wolter et al, 1994a; Wolter et al, 1994b; Wolter, 1995; Wolter et al, 1998; Manhart et al, 2000; Hickel et al, 1998; Manhart et al, 1999b).

Ormocers

Ormocers (organically modified ceramics) are organically modified, nonmetallic inorganic compound materials (Greife and Schottner, 1990). They are inorganic-organic copolymeric hybrid materials that are composed of an inorganic Si-O-Si-glass network (backbone molecule) and an organic polymer phase (Wolter et al, 1998; Moszner et al, 2002; Moszner et al, 2008).

This new material group was developed by Fraunhofer Institute for Silicate Research ISC, Würzburg, in co-operation with partners from the dental industry and introduced as a dental restorative for the first time in 1998 (Wolter et al, 1994a, Wolter et al, 1994b). Since then, remarkable further developments on ormocer-based composites have been made for this field of application. However, the use of ormocers is not limited to compact materials for dentistry. These materials already have been successfully used since years eg, in electronics, micro-system technology, refinement of plastic materials, conservation procedures and corrosion protection coatings, functional coatings of glass and highly resistant anti-scratch protective coatings (Wolter and Schmidt, 1990; Schmidt and Wolter, 1990; Ciriminna et al, 2013).

Ormocer-based dental restorative materials are currently supplied by two dental manufacturers (Admira product group, Voco; Ceramx, Dentsply). Hitherto existing



Figure 15: Adjusting static and dynamic occlusion



Figure 16: Final result: the direct ormocer restoration with cuspal replacement blends in well to the surrounding hard dental tissue

dental ormocers still contained additional conventional dimethacrylates in the monomer matrix for better handling and manipulation characteristics (in addition to initiators, stabilisers, pigments and inorganic filler particles) (Moszner et al, 2002; Moszner et al, 2008; Ilie and Hickel, 2011). Thus, it is better to refer to these materials as ormocer-based composites.

According to the manufacturer (Voco), Admira Fusion x-tra, the bulk-fill ormocer newly introduced in 2015, does not contain any conventional dimethacrylates in addition to pure ormocer chemistry. This diluent-free restorative material should show an increased biocompatibility (Moszner et al, 2002). It is filled with nanohybrid inorganic particles (84 wt %) and is available in a single universal shade.

A polymerisation shrinkage of 1.2 vol % and a low shrinkage stress have been measured for Admira Fusion x-tra, which can be applied into tooth cavities in single increments up to a maximum of 4mm layer thickness that have to be polymerised for 20 seconds each (curing light power >800 mW/cm²). The high-viscosity, sculptable consistency and the physico-mechanical properties of Admira Fusion x-tra allow the dental team to restore the complete tooth defect using a bulk-fill approach with only one restorative material from cavity floor up to the occlusal surface; it does not require a protective capping layer with an additional composite material unlike low-viscosity, flowable bulk-fill composites.

Clinical case presentation

A 34-year-old male patient requested in our dental office the replacement of his composite restoration in his LL6 (Figure 1). The tooth was endodontically treated and showed an insufficiently shaped direct composite restoration especially in the area of the replaced distolingual cusp and distal marginal ridge, which resulted in frequent food impaction with respective negative consequences. In consultation

with the patient and after an explanation of the possible restorative alternatives and treatment fee, the patient decided on a direct nanohybrid ormocer restoration using Admira Fusion x-tra (Voco).

Treatment started with thoroughly cleaning the affected tooth of external deposits using a fluoride-free prophylaxis paste and a rubber cup. Admira Fusion x-tra is only available in one single universal shade, which renders a detailed and sometimes time-consuming shade analysis unnecessary. After careful removal of the old insufficient composite restoration, while conserving the remaining hard tissues, the tooth was excavated and the root canal openings were covered with a glass ionomer base (Ionostar Plus, Voco).

The cavity was finished with a fine-grit diamond bur. The tooth was subsequently isolated with the application of rubber dam, and the defect was confined with a circular metal matrix (Figure 2). The rubber dam separates the operation site from the oral cavity, facilitates clean and effective work and ensures that the working area remains clean of contamination (eg, blood, sulcus fluid and saliva). Contamination of the enamel and dentin would result in markedly poorer adhesion of the composite to the dental hard tissues and endanger the long-term success of the composite restoration with optimal marginal integrity.

Additionally, the rubber dam protects the patient from irritating substances such as the adhesive system. The rubber dam is thus an essential aid in ensuring high quality and facilitating work in adhesive dentistry. The minimal effort required in applying the rubber dam is also compensated for the dental team by avoiding the need to change cotton rolls and the patient's frequent requests for rinsing.

Bonding process

The universal adhesive Futurabond U (Voco) was selected for bonding. This modern one-bottle adhesive can be used

with (etch-and-rinse approach: selective enamel-etch or total-etch of enamel and dentin) or without (self-etch) prior application of phosphoric acid. In this clinical case, the adhesive was applied using the self-etch technique. Ample amounts of the adhesive Futurabond U were applied and distributed generously in the area of the cavity using a microbrush (Figure 3).

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 hard dental tissues, the solvent was carefully evaporated with oil-free compressed air from the bonding agent (Figure 4), which was subsequently light-cured for 10 seconds (Figure 5).

The result was a shiny cavity surface, evenly covered with adhesive (Figure 6). This should be carefully checked, as any areas of cavity that appear dull are an indication that insufficient amount of adhesive has been applied to those sites.

In the worst case, this could result in reduced bonding of the restoration in these areas and, at the same time, in reduced dentin sealing, which may lead to postoperative sensitivity. If such areas are found in the visual inspection, additional bonding agent is selectively applied to them.

Next, a small amount of Admira Fusion x-tra was applied on the floor of the distal proximal box and the still plastic composite was shaped using a special hand instrument (Easy Contact Point, Helmut Zepf Medizintechnik), which is used for the creation of a physiologically correct formed proximal area with tight contact to the adjacent tooth (Figure 7).

By controlled pressure, the hand instrument is forced towards the mesial surface of the neighboring tooth, anatomically shaping the metal matrix and simultaneously forming a cervical composite bridge, which stabilises the matrix after polymerisation (20 seconds, light power $>800\text{mW}/\text{cm}^2$) – the instrument is kept in place during light curing – and ensures a tight proximal contact (Figure 8). The formation of physiologically contoured proximal surfaces with tight contacts to neighboring teeth still represents a challenge when using direct composite restorations.

In contrast to amalgam, composites show a certain viscoelastic recovery from distortion, which is often seen as undesirable by the user and complicates the adaptation of matrices to the neighboring tooth by packing pressure (Manhart, 2001; Kunzelmann 2001).

Final stages

With the next increment of Admira Fusion x-tra the distal proximal wall was completed up to the marginal ridge and

the outer contours of the missing distolingual cusp were built (Figure 9). The material was again polymerised with a high-performance curing light for 20 seconds (light power $>800\text{mW}/\text{cm}^2$). Thus, the class II cavity was transformed into a 'functional class I cavity'. Once the proximal composite wall was sufficiently polymerised, the matrix system was removed (Figure 10). As a result, the operating field became more easily accessible with modelling instruments for the following working steps and visual control of further subsequently to apply composite increments was enhanced. Because the remaining cavity depth still exceeded the maximum depth of cure (4mm) of the employed restorative material, a further horizontally orientated layer of Admira Fusion x-tra was placed into the cavity and polymerised for 20 seconds (Figure 11). With a last layer of Admira Fusion x-tra, the remaining volume of the cavity was completely filled up to the occlusal surface (Figure 12).

A functional but effective occlusal anatomy had been finally shaped to complete the direct ormocer restoration (Figure 13). The material was again light-cured for 20 seconds (light power $>800\text{mW}/\text{cm}^2$) (Figure 14). After removal of rubber dam, the fissure relief and 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 (Figure 15), the accessible proximal areas were contoured and prepolished with abrasive disks. The use of diamond-impregnated composite polishers (Dimanto, Voco) 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 optimise the luster of the restorative material.

Figure 16 shows the completed direct ormocer restoration with cusp replacement, reconstructing the original tooth shape with an anatomical and functional occlusal surface, a physiological formed proximal contact area, and an acceptable aesthetic appearance. To complete the treatment, a fluoride varnish (Bifluorid 12, Voco) was applied to the affected tooth using a foam pellet.

Conclusion

Composite-based direct restorative materials will 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 (Heintze and Rousson, 2012; Da Rosa et al, 2011; Van De Sande et al, 2015; Mahnart et al, 2004; Opdam et al, 2014; Opdam et al, 2010).

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%) (Manhart et al, 2004). Even cuspal coverage direct composite restorations are meanwhile used frequently and prove to be a viable alternative to conventional indirect restorations in selected clinical cases (Scholtanus and Ozcan, 2014; Laegreid et al, 2012; Deliperi and Bardwell, 2006b; Opdam et al, 2008; Fennis et al, 2014).

The growing economic pressure on the healthcare 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, faster-to-complete and therefore more economical basic posterior restorative treatment options as an alternative to the time-consuming high-end solutions (Margeas, 2014).

In addition to the universal hybrid composites, which are available in various shades and levels of opacity, new bulk-fill composites with optimised depth of cure have lately emerged on the market. They are specially designed for use in posterior dentition, where they produce aesthetically pleasing restorations. The placement procedure is economically more efficient than that of conventional hybrid composites (Manhart et al, 2009; Burke et al, 2009). Supplementary to bulk-fill composites based on traditional methacrylate chemistry, the material options in the sector of light-activated direct placement restoratives with increased curing depth were recently expanded by a nanohybrid ormocer version.

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