Posterior restoration with a new nanohybrid Ormocer composite – a clinical case report

Jurgen Manhart presents a direct composite posterior restoration case using a pure nanohybrid Ormocer restorative

Summary

Today, direct composites in posterior teeth are a very successful part of the standard therapy spectrum in modern restorative dentistry. They are very popular filling materials with dentists as well as their patients.

The performance of this treatment method, even in the masticatory load-bearing posterior region, has been conclusively proven in many clinical studies. Aside from composites based on methacrylate chemistry, the choice of filling materials has now been extended by a pure nanohybrid Ormocer restorative without any conventional methacrylate monomers in its formulation.

Introduction

For many years, the use of composite resin materials has increased along with patients' growing demand for metal-free restorations. This trend has been driven in large part by patients looking for an aesthetic alternative to repair carious lesions or traumatised teeth and patients who are concerned about potential systemic adverse reactions of amalgam restorations (Radz, 2015).

In recent years, an extensive range of new materials for direct composite restorations has emerged on the market (Kunzelmann, 2007; Kunzelmann, 2008; Ferracane, 2011; Weinmann et al, 2005). In addition to regular hybrid and nanohybrid composites for universal use, a great number of highly aesthetic composite systems were introduced to dental professionals due to rising aesthetic demands of patients. These restorative systems contain composite materials in a sufficient number of shades and different opacities or translucencies (Manhart, 2006).

Some of these composite systems comprise more than 30 different composite materials of different shades and translucency. It is therefore essential to have appropriate experience in the handling of these materials, which

Figure 1: Preoperative situation: old insufficient amalgam restoration in a UR6

Figure 2: Situation after careful removal of the existing restoration

Figure 3: Cavity was prepared and finished after caries removal

Clinical

Figure 4a: Shade selection on the moist tooth

Figure 4b: Shade selection on the moist tooth

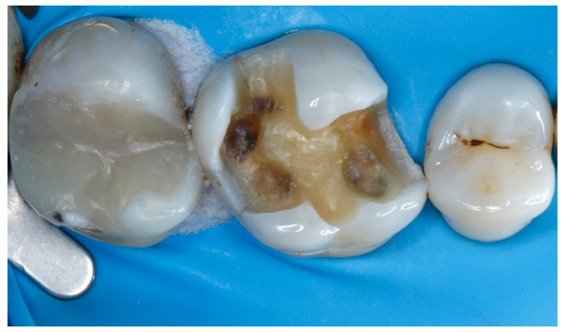

Figure 5: Isolation of the operation site with rubber dam

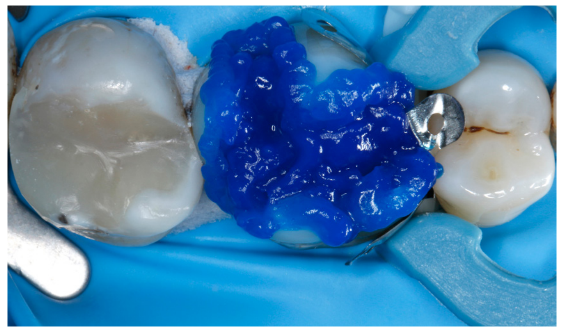

Figure 9: After 15 seconds, the etching agent is further extended on dentin for an additionally 15 seconds conditioning period (total etch)

Figure 10: Situation after thoroughly rinsing the conditioning agent and gentle air-drying the cavity avoiding desiccation of the dentin

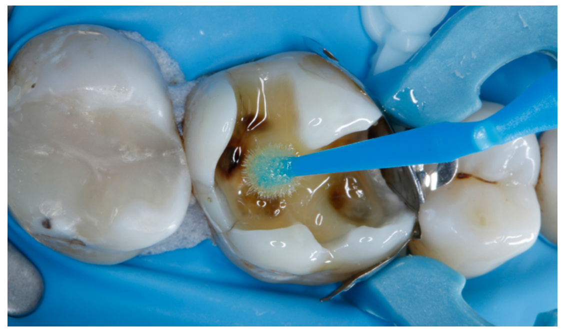

Figure 11: Adhesive pretreatment of the tooth structure with Futurabond U universal adhesive

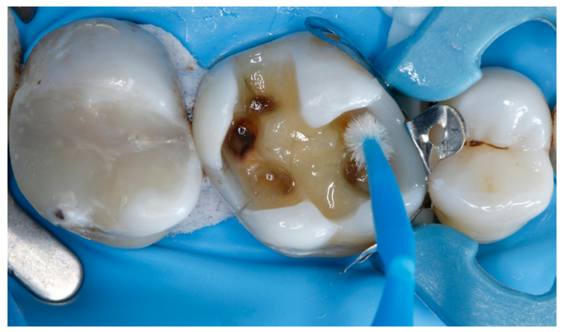

Figure 15: Admira Fusion was applied into the mesial cavity extension and built up the complete proximal wall up to the marginal ridge. The composite material was shaped with a clean microbrush

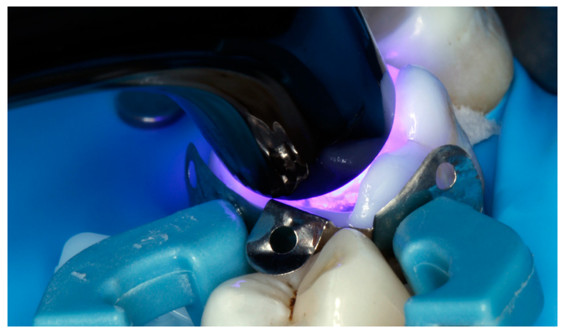

Figure 16: Light polymerisation the Ormocer Admira Fusion for 20 seconds

Figure 17: The class II cavity was transformed into a 'functional class I cavity'

are processed – especially when used for aesthetically challenging anterior situations – in the polychromatic stratification technique using varying opacities and translucencies (Manhart, 2006; Manhart, 2009).

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

The choice of filling materials has now been extended by a pure nanohybrid Ormocer restorative

Alternative chemical formulations use silorane resins (Weinmann et al, 2005; Guggenberger and Weinmann, 2000; Lien and Vanderwalle, 2010; Ilie and Hickel, 2006; Ilie and Hickel, 2009; Zimmerli, 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 (organically modified ceramics) are organically modified, non-metallic inorganic compound materials (Greiwe 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; Wolter, 2015).

This material group was developed by Fraunhofer Institute for Silicate Research ISC, Würzburg, in cooperation 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). Hitherto existing dental Ormocers still contained additional conventional monomers in the 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.

The Ormocer Admira Fusion (Voco), newly introduced in 2015, features pure Ormocer matrix chemistry without any additional conventional dimethacrylates and nanohybrid inorganic filler particles (84% wt). This diluent-free restorative material should show an increased biocompatibility (Moszner et al, 2002).

It is available in a wide range of shades in three different translucency/opacity levels (10 universal VITA shades, four opaque dentin shades, four special shades) that allows to use this material in a simplified single-shade placement technique in posterior cavities, as well as using a more complex polychromatic layering technique when restoring defects in aesthetically demanding teeth.

A polymerisation shrinkage of only 1.25% volume and a low shrinkage stress (3,87 MPa) have been measured for Admira Fusion. The Ormocer can be applied in increments of up to 2mm into tooth cavities. Each increment has to be polymerised for 20-40 seconds (intensity of the curing light >500 mW/cm^2).

Clinical case presentation

A 51-year-old female patient requested in our dental office the replacement of her insufficient old amalgam restoration in the UR6 (Figure 1). During the clinical inspection, the tooth reacted sensitively in the cold test and showed no negative reaction to the percussion test. After the patient had been informed about the possible treatment options and the corresponding costs, she decided in favour of a direct Ormocer restoration using Admira Fusion (Voco).

Treatment started with thoroughly cleaning the affected tooth of external deposits using a fluoride-free prophylaxis paste and a rubber cup. After administration of local anesthetic, the old amalgam restoration was carefully removed while conserving the remaining hard tissues (Figure 2). Due to the spatial expansion of the caries, the cavity had to be extended to the mesial surface. The tooth was excavated and subsequently the cavity completely prepared and finished with a fine-grit diamond bur (Figure 3).

The need for composite-based direct restorative materials is predicted to grow in the future. Therefore, high-quality, scientifically tried-and-tested and clinically well-documented composite resin materials will be in much demand

Shade determination was done on the moist tooth prior to the application of rubber dam (Figures 4a and 4b). The tooth was subsequently isolated with rubber dam (Figure 5). 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 filling material to the dental hard tissues and endanger the long-term success of the composite

Figure 6: Placement of a metal sectional matrix band, cervically sealed with a plastic wedge

Figure 7: Placement of the sectional matrix system ring to stabilise the metal band and separate the teeth

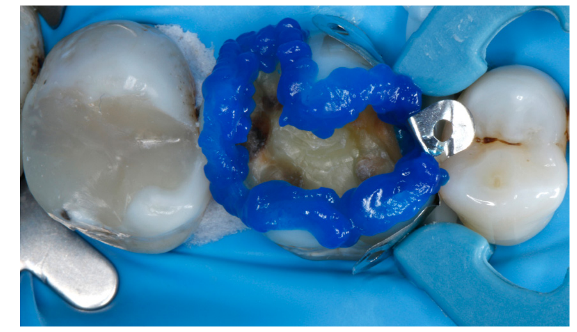

Figure 8: Selective enamel etching with 35% phosphoric for 15 seconds

Figure 12: Careful evaporation of the solvent of the adhesive until a shiny, immobile film formed

Figure 13: Light-curing the adhesive for 10 seconds

Figure 14: An even shiny cavity surface shows an appropriately pretreated tooth structure. This seals the dentinal tubules and prevents postoperative hypersensitivity

Figure 18: Once the proximal composite wall was sufficiently polymerised the matrix system was removed completely. With a further increment of Admira Fusion, the cavity floor was levelled out

Figure 19: Shaping the mesio-buccal cusp and subsequent polymerisation for 20 seconds

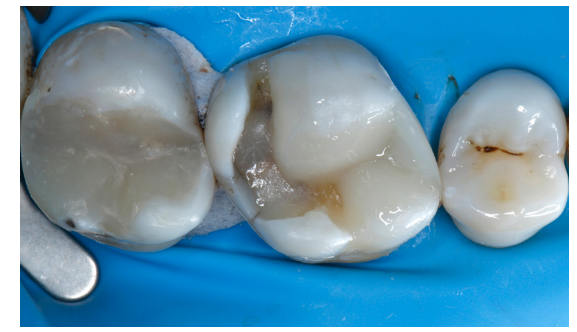

Figure 20: Shaping the mesio-palatal cusp and subsequent polymerisation for 20 seconds

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.

A sectional metal matrix system was used to delimit the three-surface cavity; it was sealed at the gingival marginal using an anatomically formed plastic wedge (Figure 6). The nickel-titanium ring stabilised the matrix and exerted optimal separation force on the neighbouring teeth to produce a tight contact for the new restoration (Figure 7).

To optimise the contours, the matrix was carefully moulded with a hand instrument. The formation of physiologically contoured proximal surfaces with tight contacts to neighbouring 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 neighbouring tooth by packing pressure (Manhart, 2001; Kunzelmann and Hickel, 2001).

The universal adhesive Futurabond U (Voco) was selected for bonding. This advanced universal adhesive is compatible with all etching techniques: self-etch and etch techniques based on phosphoric acid (etch-and-rinse approach: selective enamel-etch or total-etch-and-rinse techniques involving enamel and dentin).

In this clinical case, the adhesive was applied using the etch-and-rinse technique on both enamel and dentin. Phosphoric acid 35% (Vococid, Voco) was applied along the enamel margins first for a reaction time of 15 seconds (Figure 8), followed by an additional conditioning of the dentin for further 15 seconds (Figure 9). Subsequently the cavity was washed thoroughly for 20 seconds 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 (Figure 10). Ample amounts of the adhesive Futurabond U were applied and distributed generously in the area of the cavity using a microbrush (Figure 11). 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 oil-free compressed air from the bonding agent until a glossy, immobile adhesive film resulted (Figure 12). The bonding agent was subsequently light-cured for 10 seconds (Figure 13).

With the subsequent increments of the Ormocer restorative, the occlusal morphology of the tooth was reconstructed cusp by cusp

The result was a shiny cavity surface, evenly covered with adhesive (Figure 14). 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.

The Ormocer Admira Fusion was applied into the cavity, starting at the mesial proximal extension. The entire proximal wall was built up to the marginal ridge using a clean new microbrush as perfect modelling instrument to carefully mould the restorative material (Figure 15). The first increment of the composite was polymerised with a high-performance curing light (intensity >500mW/cm^2) for 20 seconds (Figure 16).

Thus, the class II cavity was transformed into a 'functional class I cavity' (Figure 17). Once the proximal composite wall was sufficiently polymerised, the matrix system was no longer necessary and removed completely (Figure 18). 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.

With the second layer of Admira Fusion, the cavity floor was levelled to provide an even area with a maximum increment thickness of 2mm for the following development of the anatomical structures of the occlusal surface (Figure 18).

With the subsequent increments of the Ormocer restorative, the occlusal morphology of the tooth was reconstructed cusp by cusp (sequential composite cusp technique), starting with the mesio-buccal cusp (Figure 19), followed by the mesio-palatal cusp (Figure 20), and finished by the placement of the disto-palatal and disto-buccal cusps (Figure 21). This technique allows rebuilding the occlusal anatomy in a very simple, predictable and reproducible way and results in an excellent approximation to the natural substrate.

After each single cusp placement, the restorative material was light-cured for 20 seconds (Figure 22). Additional 20-second curing cycles from mesio-palatal (Figure 23) and mesio-buccal (Figure 24) in the region of the proximal box, especially at the gingival seat, were executed after final composite placement to ensure that all areas covered before by the metal matrix band

Clinical

Figure 21: Shaping the disto-buccal and disto-palatal cusp

Figure 22: Light-curing both cusps for 20 seconds each

Figure 23: Additional polymerisation at the proximal area from palatal-lateral for 20 seconds

Figure 24: Additional polymerisation at the proximal area from buccal-lateral for 20 seconds

experienced sufficient polymerisation.

The restoration was checked for any imperfections before the rubber dam was removed. 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 discs. The use of diamond-impregnated composite polishers (Dimanto) achieved a satin matte, lustrous finish on the smooth 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 25 shows the completed direct Ormocer restoration, reconstructing the original tooth shape with an anatomical and functional occlusal surface, a physiological formed proximal contact area, and an excellent aesthetic appearance. To complete the treatment, a fluoride varnish (Bifluorid 12, Voco) was applied to the affected tooth using a foam pellet.

Conclusion

The need for composite-based direct restorative materials is predicted to grow in the future. Therefore, high-quality, scientifically tried-and-tested and clinically well-documented composite resin materials will be in much demand. 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 (Da Rosa Rodolpho et al, 2011; van de Sande et al, 2015; Manhart et al, 2004; Heintze and Rousson, 2012; Opdam et al, 2014; Opdam et al, 2010).

The results of a comprehensive review have shown that the annual failure rate of direct composite restorations in posterior teeth (2.2%) is not statistically different to that of amalgam restorations (3.0%) (Manhart et al, 2004).

Minimally invasive treatment protocols in conjunction with the possibility of detecting carious lesions at a very early stage are having a positive effect on the long-term survival rate of dental restorations. Nonetheless, a high-quality direct composite restoration with excellent marginal adaptation continues to be dependent on a number of prerequisites, eg careful placement of the matrix (if proximal areas are involved), effective and correct application of the adhesive system, appropriate handling of the restorative material and sufficient curing of the composite.

Supplementary to composites based on traditional methacrylate chemistry, the material options in the sector of light-activated direct placement restoratives were expanded by a nanohybrid Ormocer version that does not contain any more conventional dimethacrylates in its chemical formulation. **D**

References

Da Rosa Rodolpho PA, Donassollo TA, Cenci MS, Loguércio AD, Moraes RR, Brockhorst EM, Opdam NJ, Demarco FF (2011) 22-Year clinical evaluation of the performance of two posterior composites with different filler characteristics. *Dent Mater* **27(10):** 955-963

Ferracane JL (2011) Resin composite – state of the art. *Dent Mater* **27(1):** 29-38

Greiwe K, Schottner G (1990) ORMOCERe: Eine neue Werkstoffklasse. *FhG-Berichte* **2:** 64-67

Guggenberger R, Weinmann W (2000) Exploring beyond methacrylates. *American Journal of Dentistry* **13(Special Issue):** 82D-84D

Heintze SD, Rousson V (2012) Clinical effectiveness of direct class II restorations - a meta-analysis. *J Adhes Dent 14(5):* 407-31

Hickel R, Dasch W, Janda R, Tyas M, Anusavice K (1998) New direct restorative materials. FDI Commission Project. *Int Dent J* **48(1):** 3-16

Ilie N, Hickel R (2006) Silorane-based dental composite: behavior and abilities *Dent Mater J* **25(3):** 445-454

Ilie N, Hickel R (2009) Macro-, micro- and nano-mechanical investigations on silorane and methacrylate-based composites. *Dent Mater* **25(6):** 810-819

Ilie N, Hickel R (2011) Resin composite restorative materials. *Aust Dent J* **56(Suppl 1):** 59-66

Kunzelmann KH, Hickel R (2001) Klinische Aspekte der Adhäsivtechnik mit plastischen Werkstoffe. In: Espe M (ed) *Die Adhäsivtechnologie. Ein Leitfaden für Theorie und Praxis.* 3M Espe: Seefeld, Germany: 46-67

Kunzelmann KH (2007) Komposite – komplexe Wunder moderner Dentaltechnologie. Teil 1: Füllkörpertechnologie. *Ästhetische Zahnmedizin* **10(3):** 14-24

Kunzelmann KH (2008) Komposite – komplexe Wunder moderner Dentaltechnologie. Teil 2: Matrixchemie. *Ästhetische Zahnmedizin* **11(1):** 22-35

Lien W, Vandewalle KS (2010) Physical properties of a new silorane-based restorative system. *Dent Mater* **26(4):** 337-44

Manhart J (2001) Eine Alternative zu Amalgam? Hochvisköse stopfbare Komposite: Überblick, Eigenschaften und Verarbeitungshinweise. *KONS-Journal* **3:** 21-26

Manhart J (2006) Charakterisierung direkter zahnärztlicher Füllungsmaterialien für den Seitenzahnbereich. Alternativen zum Amalgam? *Quintessenz* **57(5):** 465-481

Manhart J (2009) Direkte Kompositrestauration: Frontzahnästhetik in Perfektion. *ZWP Zahnarzt-Wirtschaft-Praxis* **15(10):** 42-50

Manhart J, Chen HY, Kunzelmann KH, Hickel R (1999b) Werkstoffkundliche Charakterisierung eines Füllungsmateriales auf Ormocer-Basis im Vergleich zu einem Komposit und einem Kompomer. *ZMK* **15(12):** 807-812

Manhart J, Chen H, Hamm G, Hickel R (2004) Review of the clinical survival of direct and indirect restorations in posterior teeth of the permanent dentition. *Oper Dent* **29(5):** 481-508

Manhart J, Kunzelmann KH, Chen HY, Hickel R (2000) Mechanical properties and wear behavior of light-cured packable composite resins. *Dental Materials* **16(1):** 33-40

Figure 25: Final situation: the high-gloss polished direct Ormocer restoration shows a successful aesthetic and functional integration into the surrounding dental tissue

Manhart J, Hollwich B, Mehl A, Kunzelmann KH, Hickel, R (1999a) Randqualität von Ormocer- und Kompositfüllungen in Klasse-II-Kavitäten nach künstlicher Alterung. *Deutsche Zahnärztliche Zeitschrift* **54:** 89-95

Moszner N, Gianasmidis A, Klapdohr S, Fischer UK, Rheinberger V (2008) Sol-gel materials 2. Light-curing dental composites based on Ormocers of cross-linking alkoxysilane methacrylates and further nano-components. *Dent Mater* **24(6):** 851-856

Moszner N, Völkel T, Carmer von Clausbruch S, Geiter E, Batliner N, Rheinberger V (2002) Sol-Gel Materials, 1. Synthesis and Hydrolytic Condensation of New Cross-Linking Alkoxysilane Methacrylates and Light-Curing Composites Based upon the Condensates. *Macromol Mater Eng* **287(5):** 339-347

Opdam NJ, Bronkhorst EM, Loomans BA, Huysmans MC (2010) 12-year survival of composite vs. amalgam restorations. *J Dent Res* **89(10):** 1063-1067

Opdam NJ, van de Sande FH, Bronkhurst E, Cenci MS, Bottenburg P, Pallesen U, Gaengler P, Lindberg A, Huysmans MC, van Dijken JW (2014) Longevity of posterior composite restorations: a systematic review and meta-analysis. *J Dent Res 93(10):* 943-949

Peutzfeldt A (1997) Resin composites in dentistry: the monomer systems. *Eur J Oral Sci* **105(2):** 97-116

Radz GM (2015), Direct Composite Resins. The most critical improvements have come in the filler particles. *Inside Dentistry* **7(7):** 108-114

van de Sande FH, Rodolpho PA, Basso GR, Patias R, da Rosa QF, Demarco FF, Opdam NJ, Cenci MS (2015) 18-year survival of posterior composite resin restorations with and without glass ionomer cement as base. *Dent Mater* **31(6):** 669-675

Weinmann W (2005) Thalacker C, Guggenberger R (2005) Siloranes in dental composites. *Dent Mater* **21(1):** 68-74

For a full list of references, contact julian@dentistry.co.uk.

Dr Jurgen Manhart is a professor in the Department of Restorative Dentistry, Dental School of LMU-University in Munich, Germany. He offers seminars and practical hands-on workshops in aesthetic restorative dentistry, such as direct composite restorations, all-ceramic restorations, post-endodontic treatment, management of severely worn dentition and treatment planning in aesthetic dentistry.

PROFESSOR MANHART CAN be reached via email at manhart@manhart.com. Alternatively, visit www.manhart.com and www.dental.education.