Nanotechnology, on the other hand, has made successful inroads into modern composite technology and continues to be the subject of considerable research work. Nano-sized inorganic fillers enable the filler content of composite pastes to be maximised while retaining excellent clinical handling properties and at the same time minimising the percentage of organic resin matrix. This results in dental filling composites with greatly improved mechanical properties.

Case history

The following clinical case history illustrates the different stages in the treatment of a primary carious lesion in an upper second premolar (tooth 15) with a new type of nanohybrid composite.

The clinical examination of a 27-year-old female patient indicated penetration of the tooth structure caused by caries at the mesial surface of tooth 15 (Fig. 1). The tooth was immediately sensitive when anything cold was applied and did not exhibit any abnormal reaction to the percussion test. Following an explanation of possible treatment options, the patient decided on a plastic composite restoration of the tooth with Grandio nanohybrid composite (VOCO, Cuxhaven, Germany).

The shade of the tooth (A2) was determined in daylight with the system shade guide (Fig. 2). The shade was taken before placing the rubber dam, as the temporary whitening of the tooth due to loss of moisture and also the strong contrast produced by the coloured rubber dam would have made it impossible to select the correct shade. The two premolars were separated with the retention ring of a sectional matrix system. This moved the teeth minimally in the same way as wedging and reduced the risk of iatrogenic damage to the adjacent tooth during preparation. The caries was exposed occlusally by extending...
the defect opening with a diamond rotary instrument. The extent of the caries made it necessary to extend the margins of the cavity towards the palatal (Fig. 3).

In the next stage, the tooth cavity was isolated from the rest of the oral cavity with a rubber dam. The rubber dam was clamped to the first molar to isolate the working area. The rubber dam creates a boundary between the operating site and the oral cavity, facilitates effective and clean preparation and guarantees the working area is kept free from contaminating substances, such as blood, sulcus fluid and saliva. Contamination of the enamel and dentine would significantly impair the adhesion of the composite to the tooth structure and put at risk the long-term success of a restoration with optimum marginal integrity. The rubber dam also protects the patient from irritant substances, such as the components of the dentine bonding agent. This makes the rubber dam an important accessory in facilitating treatment and providing quality assurance in the adhesive technique. The minimum expenditure required for placing a rubber dam is also offset by not having to change cotton wool rolls and ask patients to rinse out. The working area can be isolated before or after preparation.

Following excavation of the caries, dentine sections in the area of the pulp were coated with a self-curing calcium hydroxide paste (Calcimol, VOCO) (Fig. 4). The preparation was finished and smoothed by removing the fragile enamel sections at the cavity margins with an oscillating preparation system (Sonicsys Micro, Kavo, Biberach, Germany). In contrast to rotary instruments, the diamond coating on one side of the working tips of the Sonicsys system ensures that there is no iatrogenic damage to the adjacent teeth. The cavity was sealed off with a preformed metal sectional matrix. The matrix was retained cervically with a retention ring, which simultaneously separated the teeth to allow for the thickness of the matrix. Initially the tooth structure was conditioned by selectively applying a 37% phosphoric acid gel to the enamel of the cavity margins. After approx. 15 sec., the whole cavity was filled with etching gel, and the enamel and dentine were conditioned for another 15 sec. according to the total etch technique (Fig. 5). Most of the acid was then rinsed off with a water jet before the cavity was cleaned of residual acid debris and loosened inorganic particles using the compressed air/water spray. The cavity was then carefully dried with oil-free compressed air. It is essential to avoid overdrying the dentine, as this would result in the collapse of the fragile, three-dimensional woven collagen fibres, which were exposed by the effect of the acid. This would considerably reduce the bond strength.

Figure 6 illustrates the application of a liberal amount of Solobond M bonding agent (VOCO, Cuxhaven) to the enamel and dentine using the Micro Tim minibrush. A reaction time of 30 sec. was allowed. The acetone solvent was carefully evaporated from the adhesive system using oil-free compressed air. The bonding agent was then light-
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The composite was applied as far as possible without excess, and the occlusal surface was carefully contoured in the plastic state (Fig. 10). This significantly facilitated subsequent preparation and effectively reduced it to only a few minor working stages.

The rubber dam was removed after the filling had been examined for any deficiencies. The contours of the fissures and the fossae were accentuated with a pear-shaped finishing diamond. The convexity of the triangular ridge and marginal ridge was contoured with a grenade-shaped finishing diamond, and the fissures were then accentuated again with a fine, tapering finishing diamond. After removing any remaining roughness and optimising the junction between the tooth structure and composite with a small Arkansas stone, the surface of the filling was prepolished with rubber composite polishers to a silky smooth sheen. The static and dynamic occlusion was then checked with black and red articulating foil (Fig. 11), before the surface of the filling was polished to a final high-lustre with single-use foam polishers on mandrels and composite cured for 20 sec. (Fig. 7). The cavity should then be carefully checked to ensure that it has been uniformly coated with bonding agent. The whole surface should appear shiny. Matt cavity areas are an indication that insufficient adhesive has been applied to those areas. At worst, this could result in reduced adhesion of the filling in those areas with impaired dentinal sealing and could possibly also be accompanied by postoperative hypersensitivity. If matt areas are found when making a visual check, bonding agent should be reapplied to these areas.

Figure 8 illustrates the application of the first layer of Grandio nanohybrid composite (VOCO, Cuxhaven) to the cavity floor with a manual instrument. It is important to ensure that the filling material is carefully adapted to the internal angles and edges of the cavity without bubbles. The composite was cured with a high-output polymerisation lamp for 20 sec. The defect was fully built up incrementally with further layers of composite. Figure 9 illustrates the final layer of composite being cured. After removing the matrix, the restoration already had a good contour. The composite was applied as far as possible without excess, and the occlusal surface was carefully contoured in the plastic state (Fig. 10). This significantly facilitated subsequent preparation and effectively reduced it to only a few minor working stages.

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shade match of the filling to the adjacent tooth structure. Finally, fluoride varnish was applied to the tooth with a foam pellet to protect the enamel next to the filling. Contact with the enamel was unavoidable during preparation.

**Conclusion**

The clinical lifespan of adhesive restorations is determined to a great extent by how well the margins are adapted to the tooth structure. Marginal fit and adaptation of tooth-coloured fillings are critical factors for clinical success\(^{18}\). Factors affecting marginal integrity include polymerisation shrinkage, bond strength, wetting properties, cavity geometry, c-factor, treatment technique, the experience of the operator and even possible difficulties in accessing posterior cavities\(^{19-21}\). Marginal integrity as well as resistance to wear and tear are important parameters that contributes decisively to the clinical durability of composite-based filling materials. The surface hardness

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**Fig. 8:** Applying the first layer of composite (Grandio) to the cavity floor using a manual instrument.

**Fig. 9:** Light-curing each layer of composite for 20 sec.

**Fig. 10:** Situation after removing the matrix.

**Fig. 11:** Checking the static and dynamic occlusion after preparing and prepolishing the filling.

**Fig. 12:** The finished restoration restores the occlusal anatomy functionally and aesthetically. The approximal contact is contoured physiologically tight and the filling is an excellent shade match.
determines the durability of the polish and the abrasion resistance of the restoration material. This ensures that the vertical dimension, tight approximal contacts and an adequate anatomical contour of the filling are maintained.

A comprehensive analysis of clinical studies revealed that the lifespan of composites in the posterior region (0.3 to 6.5% annual loss rate) is similar to the survival rate of amalgam fillings (0.6 to 7% annual loss rate). It must be added, however, that these studies relate to posterior composites mainly in a highly selective group of patients and generally to cavities completely surrounded by enamel. There are a number of measures that are critical for the long-term success of composites. These include using an incremental layering technique to minimise the negative effects of polymerisation shrinkage inherent in the system and a suitable matrix technique as well as contamination-free application of a bonding agent to the tooth structure using an effective total-etch adhesive or self-conditioning bonding agent. Innovative variations of the polymerisation power (standard or soft start polymerisation, pulse-delay technique) and defect orientated, minimally invasive preparation techniques also have a significant influence.

Generally the influencing factors that determine the lifespan of a composite-based dental restoration can be classified as being patient, operator or material-orientated.

References