The use of composite combinations in posterior teeth

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Summary:
Today, direct composites in posterior teeth are a part of the standard therapy spectrum in modern conservative-restorative dentistry. The performance of this method of treatment, even in the masticatory load-bearing posterior region, has now been conclusively proven in many clinical studies. This procedure is usually carried out in an elaborate layer technique. This time-consuming procedure requires an economically sensible fee, corresponding to the effort involved. 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 therefore economical to prepare composite-based materials for posterior teeth.

Keywords:
Composite, posterior tooth, adhesive technique, direct restorations, metal-free restorations

Introduction
Composite restoration materials have been in use for more than two decades as an aesthetic alternative to metal restorations in the posterior region, which bears a great deal of the masticatory load, with increasing frequency in recent years [1]. The early clinical data on the posterior region, gathered in the early 1980s, was not encouraging, primarily due to insufficient mechanical properties. The low abrasion resistance of those composite materials led to loss of restoration contours. Fractures, marginal deterioration and leakage following polymerisation shrinkage were further reasons for the limited lifespan of those restorations [2-5]. Predominantly in recent years, these inadequacies have been greatly reduced through further developments in the materials of the composite and adhesive systems [6]. Nevertheless, the negative effects of polymerisation shrinkage – such as poor marginal integrity, insufficient adherence to the cavity walls or cusp deflections – still represent the greatest problem in composite-based materials [7].

Today, hybrid composites or hybrid composites modified with nanoparticles are the material of choice when using a direct restoration technique for the permanent treatment of larger primary carious lesions or the replacement of older, insufficient restorations in the posterior region. Prerequisites are the correct use of the matrix technique and adequate moisture control of the cavity [8]. Composites are processed in the incremental layer technique, usually in single increments with a maximum layer thickness of 2 mm. The individual increments are in turn each polymerised separately, with exposure times of 10-40 seconds depending on the light intensity of the curing device and shade/translucency of the respective composite paste. Above all in large posterior tooth cavities this can be a very time-consuming procedure that, for economic reasons, requires a corresponding fee to cover the costs. However, many users wish for an alternative to the complex, time-consuming multiple-layer technique, in order to be able to process composites in a shorter time and therefore more economically [9]. In recent times several interesting innovations have become ready to market in respect of this.

Economical processing of composites in the posterior region
In recent years, the dental industry has introduced numerous highly aesthetic composite systems to the market. With correct application, this enables direct restorations to be achieved that are practically impossible to tell apart from the dental hard tissue and can compete with the aesthetics of ceramic inlay restorations. These restoration systems contain composite materials in a sufficient number of shades and different opacities or translucencies (e.g., Filtek Supreme XTE, 3M Espe; Ceram-X Duo, Dentsply; Enamel HFO, Micerium; Esthet-X, Dentsply; Venus, Heraeus-Kulzer; Premise, Kerr; IPS Empress Direct, Vivadent). Some of these composite systems comprise more than 30 different composite materials of different shades and transparency. It is therefore essential to have appropriate experience in the handling of these materials, which are processed in the layer technique using varying opacities and translucencies [10].

Aside from the possibilities that highly aesthetic composites offer in the application of polychromatic multi-layer techniques, there is also a great demand in the dental profession – in some cases under great economical pressure – for the most simple and quick
and therefore economical to prepare composite materials for posterior teeth (6). The restorative material amalgam, which has been used successfully for decades, is now fundamentally no longer acceptable to many patients. Nowadays, patients predominantly demand metal-free restorations in the treatment of posterior tooth defects. While many patients avoid amalgam, above all due to insecurity about potential side effects, but also due to a lack of aesthetics, and this is therefore also no longer offered by a significant number of dentists, the phenomenon that gold inlay restorations are also increasingly being refused can be traced back to patients’ increased awareness of dental health and their desire for tooth-coloured restorations (11, 12).

For the treatment of lesions in the masticatory load-bearing posterior tooth area which do not yet require complete crowning, plastic composite restorations, indirect composite inlays or onlays and ceramic inlay restorations are available to the dentist as long-term, clinically successful alternatives. The indication spectrum for direct composites in posterior teeth has distinctly increased in recent years. Whilst previously mainly small to medium-sized cavities, preferably bounded by enamel, were treated with direct composites, the steady, continuous improvement in composite materials and related adhesive systems, combined with positive experience from numerous clinical trials, have resulted in the possibility to greatly increase these indications. Today, Class I and II defects, without explicit qualification of size, can be successfully treated with direct composite restorations, even including the replacement of individual cusps, and without the need for circular enameling limitation. However, especially in very extended defects, it should always be ascertained if individual cases would benefit more from indirect restorations [ceramic or gold inlay restorations], due to better stabilization of weakened hard tissue, limited accessibility to the treatment area or expected problems in shaping the proximal contacts. If it is not possible to keep the treatment area dry, leading to a danger of contamination of the cavity site with blood, saliva or sulcus fluid, an adhesive restoration should certainly be avoided.

Composite restorations have been shown to be highly successful in the treatment of posterior teeth (13). However, the basic rules for the adhesive technique must be adhered to in such cases. These include, for example, careful observance of the adhesive protocol, the increment technique with observance of the curing depth of the individual layer of the respective composite, sufficient light-polymerisation and careful finishing and polishing (14). In general, adhesive restorations show a great deal of technique sensitivity. The same material often shows highly significant variation in the success achieved by different users (15).

The correct observation of the rules of the adhesive technique is extremely time consuming for the dentist. This must be reflected in economically calculated prices corresponding to the effort required. However, many non-privately insured patients are simply financially unable to take on the corresponding additional costs. With this group of patients, dentists regularly find themselves in the following dilemma:

- the patient does not want to opt for amalgam;
- glass ionomer cements [and derivatives], as well as other cement restoratives, are currently not suitable as permanent restorations due to an increased risk of fracture or wear in the areas affected by masticatory loads [16];
- the amount of the additional costs for multi-layer direct composite restorations with dentine-adhesive fixation exceeds the patient’s budget and
- crowning is not yet indicated, and would also be accompanied by extensive additional costs to the patient.

On the other hand, one cannot expect the dentist to set an economically absurd, low price for a high-quality, time-consuming type of restoration produced using not exactly inexpensive composites, which would result in the dentist making a loss at the end of the day. The basics of business economics must not be forgotten in this: The price of a treatment is made up of the materials used, the time taken and all costs connected with this, which include, among others, the cost of staff, property rental, depreciation, etc., plus energy and storage costs and finally the clinician’s own salary. In order to treat patients who are only able to manage smaller private contributions, therapies must be available that show both reasonable clinical performance in the highly stressed posterior teeth, as well as being economically sensible for the dentist to deliver. Accordingly, the desire for restorative materials that are faster and easier to process and can therefore be offered at a lower price is totally understandable (17). Many practices have a patient structure that demands an economical treatment strategy with less demanding restoration types (12).

Basic treatment in conservative dentistry would benefit from a material as an alternative to amalgam, whose limited sensitivity to technique it would combine with the structurally stabilising properties of the adhesive technique. The visual properties of such a material for posterior teeth are of less importance for patients, as long as the result is not metallic or cement-like and extremely opaque. In the author’s view, it is even of advantage if in comparison to the highly aesthetic composite restorations, which are much more laboriously applied using the polychromatic multi-layer technique, a distinct difference can also be perceived by the patient.

A number of composite manufacturers have assimilated the demands of practitioners into their requirement specification for material development and are trying to simplify composite-based restoration techniques in the posterior region. For this so-called “fast-track” restoration technique, simplified bonding agents (usually single-step, self-conditioning adhesive systems) are used in combination with low-shrinkage, mechanically sufficiently stable composite materials that can be applied directly into the cavities (17, 18).

In general, the following factors, amongst others, can contribute to placing a light-curing composite restoration in posterior teeth faster and therefore more economically:

- Universal shade of the restorative material > Omission of the sometimes complicated shade selection (especially if the patient is potentially included in this)
- Extremely translucent shade of the composite > Greater curing depth per layer, meaning fewer increments
- Optimisation of the light-curing composite’s initiator system > Shorter exposure times
- Low-shrinkage composite materials with minimal tension build-up > Greater layer thicknesses, meaning fewer increments
- Powerful polymerisation lights > Shorter exposure times with high intensity
- Functional but efficient occlusal forming > Faster finishing and polishing

The “fast-track” composites should, with the best possible quality of restoration margins, be easy to handle (19) and less sensitive to technique, and should additionally provide more economical processing techniques and thus save time in placement (20). As most of these composites are only supplied in a single shade, selection of the matching shade is also no longer required. Despite this, the use of these materials results in entirely aesthetically pleasing results, especially in comparison with amalgam and glass ionomer cements. For the purpose of a comprehensive fast-track concept,
These composites are normally used in combination with self-conditioning bonding agent systems, without the use of separate enamel-dentine etching.

The material properties of these composites, optimised to be economical, are comparable with conventional light-curing composites (21). Data from clinical trials shows good intraoral performance (22-24).

**x-tra base composite**

The low-viscosity, flowable composite x-tra base (filler content: 75% by weight) (VOCO, Cuxhaven) is a flow composite of reduced shrinkage on a traditional methacrylate basis. It is indicated for the bulk filling technique, in order to introduce a maximally 4 mm thick restoration base (“cavity lining”) in Class I and II composite restorations. In a subsequent step after curing, this must be covered in the region of the occlusal anatomy by another layer of a methacrylate-based hybrid composite at least 2 mm in thickness and suitable for posterior teeth, such as the nanoparticle-modified hybrid composite GrandioSO (VOCO, Cuxhaven). Alternatively, x-tra base can also be applied in the first thin layer as a cavity liner in Class I and II cavities. x-tra base is supplied in the shades Universal and A2. Depending on the light output of the polymerisation device and the selected shade, the polymerisation time is: 10 s for the “Universal” shade, if the light output is at least 500 mW/cm²; 20 s for the shade “A2”, if the light output is at least 800 mW/cm²; otherwise 40 s (500 to 800 mW/cm²).

**Clinical case**

The following clinical case is a stage-by-stage representation of the replacement of 3 old, insufficient composite maxillary posterior tooth restorations with the composite combination of x-tra base and GrandioSO (VOCO) in a clinical step-by-step series, as part of a fast-track procedure.

A patient complained of osmotic or thermal irritation in her first quadrant posterior teeth, which contained old composite restorations with unsealed margins. During the clinical inspection, the teeth reacted sensitively in the cold test and showed no reaction to the percussion test. In consultation with the patient it was decided to replace the insufficient composite restorations. After an explanation of the possible treatment alternatives, the patient decided on plastic restorations with the composite combination x-tra base and GrandioSO.

Treatment started by thoroughly cleaning the affected teeth in the first quadrant of external deposits using a fluoride-free prophylaxis paste and a rubber cup (Fig. 1). After careful removal of the inefficient composite restorations, whilst conserving the remaining hard tissue, the teeth were excavated, the cavities completely prepared and finished with a fine diamond bur. Figure 2 shows the situation after the application of the rubber dam. The rubber dam separates the operation site from the oral cavity, facilitates clean and effective work and guarantees that the working area remains clean of contaminating substances such as blood, gingival sulcal and saliva. Contamination of the enamel and dentine would result in distinctly poorer adhesion of the composite to the dental hard tissue and endanger the long-term success of a 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 quality and facilitating work in the adhesive technique. The minimal effort required in applying the rubber dam is also compensated by avoiding the changing of cotton rolls and the patient’s requests for rinsing.

Initially, both premolars were restored in parallel. Metal female parts were anchored with wooden wedges in order to delimit each of the triple surface MOD cavities (Fig. 3). In order to optimise the contours, the female parts were then also carefully moulded with a medium-sized ball plugger (cold-forming). The formation of a physiologically contoured proximal surface with tight contact to neighbouring teeth still represents a challenge when using composites. In contrast to amalgam, composites show a certain visco-elastic recovery from distortion, which is often seen as undesirable by the user and which complicates the adaptation of female parts to the neighbouring tooth by packing pressure (25, 26).

The self-conditioning adhesive Futurabond DC (VOCO) was selected for bonding. The self-etching adhesive was applied and distributed generously in the area of the cavities using a mini brush [Fig. 4]. It must be ensured that all cavity areas are sufficiently covered by the adhesive. After at least 20 seconds of carefully massaging the adhesive into the hard dental tissue, the solvent was carefully evaporated with pressure (25, 26).

The self-conditioning adhesive Futurabond DC (VOCO) was selected for bonding. The self-etching adhesive was applied and distributed generously in the area of the cavities using a mini brush [Fig. 4]. It must be ensured that all cavity areas are sufficiently covered by the adhesive. After at least 20 seconds of carefully massaging the adhesive into the hard dental tissue, the solvent was carefully evaporated with oil-free compressed air from the bonding agent, which was subsequently cured for 10 seconds with a polymerisation light [Fig. 5]. The result was a shiny cavity surface, evenly covered with adhesive [Fig. 6]. This should be carefully checked, as any areas of cavity that appear matt are an indication that insufficient 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 dentine sealing, which may lead to postoperative sensitivity. If such areas are found in the visual inspection, additional
The deepest areas of the cavities were measured with a scaled periodontal probe, as x-tra base can be applied in the bulk technique in layer thicknesses of up to 4 mm [Fig. 7]. However, approx. 2 mm must remain in the area of the occlusal anatomy for completion of the restoration using a methacrylate-based composite suitable for posterior teeth.

The composite x-tra base, in the translucent Universal shade, was applied as a cavity lining in the bulk technique in a layer thickness of 4 mm, injecting directly into both cavities from the non-dripping NDT syringe, and starting at the deepest area of the defect [Fig. 8]. In order to avoid the inclusion of air bubbles, the thin metal tip of the syringe should constantly remain submerged in the material flowing out. Within a few seconds, the flowability of the material leads to self-levelling of the composite layer. Any visible air bubbles in the material should be eliminated with a probe tip. The translucent composite x-tra base was cured with a high-performance polymerisation light [luminous intensity > 800 mW/cm²] for 10 seconds per cavity [Fig. 9]. Figure 10 shows the cavities, evenly filled with x-tra base, with around 2 mm of occlusal remaining distance still available for the shaping of the occlusal anatomy, using a methacrylate-based composite suitable for posterior teeth.

The masticatory surfaces of both premolars were built up in one further step with the composite GrandiosO in shade A2 [Fig. 11], completing the restorations [Fig. 12]. After 10 seconds of polymerisation [luminous intensity > 800 mW/cm²], the restorations were checked for imperfections and the metal female parts were finally removed. This composite restoration was finished and polished in the area of the distal region that would later not be accessible, before the restoration of the first molar was started.

The triple surface cavity in the first molar was then delimited with a metal female part, which was anchored with wooden wedges [Fig. 13]. After adhesive pre-treatment with the self-conditioning adhesive Futurabond DC [Fig. 14 and 15], the composite x-tra base in Universal shade was applied as a cavity lining directly into the cavity in the bulk technique with a layer thickness of 4 mm [Fig. 14]. It was again ensured that there was still 2 mm of occlusal room for the covering layer. After at least ten seconds of polymerisation [Fig. 17], x-tra base was covered with a layer of GrandiosO [shade A2] [Fig. 18]. After a final polymerisation cycle [Fig. 19] the female part was removed [Fig. 20]. Figure 21 shows all 3 restorations before finishing.

Once the rubber dam was removed,
the fissure relief and fossae were finished with a pear-shaped finishing diamond bur. In the next step of the standard finishing sequence, a crystalline diamond finisher with a rounded tip was used to finish the convexity of the triangular bulges, as well as a harmonic joint between the individual components of the occlusal anatomy. After the elimination of occlusal interferences and adjustment of the static and dynamic occlusion, the accessible proximal areas were contoured and pre-polished with polishing wheels. The use of diamond-interspersed composite polishers (Dimanto, VOCO) achieved a satin matt, lustrous finish on the surface of the restorations. The subsequent high-gloss polishing was carried out using the same Dimanto polishers with reduced pressure and optimised the lustre of the restoration material. Figure 22 shows the completed direct restorations with the composite combination x-tra base and GrandioSO in maxillary posterior teeth, reconstructing the original tooth shapes with anatomically functional masticatory surfaces and physiologically formed approximal contacts. Finally, a foam pellet was used to apply the fluoride varnish Bifluorid 12 (VOCO) to the affected teeth.

5. Final remarks
The importance of direct composite-based restorative materials will continue to increase in the future. These are scientifically verified, high-quality permanent restorations for the masticatory load-bearing posterior region, whose reliability has been documented in literature. The results of a comprehensive meta-analysis have shown that the annual rates of loss are not statistically different to amalgam restorations [13]. Minimally invasive treatment protocols, in combination with the ability to detect carious lesions ever earlier, also have a positive effect on the “lifespan” of such restorations. However, in order to ensure a high-quality direct composite restoration with good marginal adaptation, a careful matrix technique (with approximal involvement), an effective dentine adhesive, the correct processing of the restorative material and the achievement of a sufficient level of polymerisation of the composite continue to be basic prerequisites.

The increasing financial pressure in the health care system and the, in many cases, lacking financial means of patients with regard to additional payments adequate to services, require, aside from time-consuming high-end restorations, a simpler, faster to complete and therefore more economical basic treatment. However, composite-based basic treatment will not manage completely without private contributions (persons insured via statutory health insurance scheme). The time advantage associated with the “fast-track” technique can however reduce these accordingly.

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