OPINION

VERIFIABLE CPD PAPER

IN BRIEF

- Points out that the use of dental amalgam as a restorative is declining.
- Explains that many practitioners remain reluctant to use resin composites in posterior teeth but attitudes vary internationally.
- Suggests that the longevity of composites is set to increase while amalgam has reached its zenith.
- Defines specific requirements for choosing composite materials for anterior and posterior situations.

Can a single composite resin serve all purposes?

J. J. M. Roeters,[1] A. C. C. Shortall[2] and N. J. M. Opdam[3]

The consensus view less than a decade ago was that direct posterior composites should be restricted to small restorations, preferably in premolar teeth with little, if any, occlusal function. Major advances in adhesive systems, materials and restorative techniques have combined to allow us to question this view and our increased clinical evidence base makes it appropriate to reconsider this viewpoint.

INTRODUCTION

In 1996 an article was published which stated that the indications for composites are all types of restorations (including cusp-capping and crowns).[1] According to the author the only limiting factor was the skill of the operator.[1] The following year a multi-author paper stated that the consensus view from the current literature was that posterior composites should be limited to small class I and II restorations, preferably in premolar teeth with little, if any, occlusal function, in young adult patients who have benefited from advances in preventive dentistry and maintain a high standard of oral hygiene.[2] The authors considered that the use of composite remained limited in the restoration of deciduous molar teeth, given the resurgence in the use of glass polyalkenoate (ionomer) cements (GIC) and the introduction of resin-modified GICs. These authors considered that despite the inherent limitations in composition and construction of current composites, their technique sensitivity, relatively high cost and uncertain long term (> 10 year) performance, they may be considered as the material of choice for the restoration of ultra-conservative and small Class I and Class II preparations in posterior teeth.

Much has changed since this paper was published and new knowledge, coupled to our increased clinical evidence base makes it appropriate to reconsider this position statement. Since then, the number of dental practitioners skilled in posterior composite use has increased as in most European dental schools students learn about adhesive restorative techniques and are taught placement of composite restorations in Class I and II situations. Also in general dental practice the use of dental amalgam as a restorative is declining while the number of composite restorations increases.[3] It has been pointed out that many dentists remain reluctant to use resin composites in posterior teeth, either because of their mediocre reputation or because the confusion over restorative concepts and techniques makes their successful application doubtful.[4] These authors go on to explain that major advances in adhesive systems, materials and restorative techniques have combined to generate significant new restorative opportunities for direct posterior composites thus making them an essential material for practitioners. They also remind us that successful clinical application relies upon appropriate materials selection for a given situation, coupled with a sound understanding and implementation of effective application techniques. In addition a certain, minimum case specific level of operator competence (proficiency) is required. While the clinical performance history of amalgam restorations is still generally superior to that of posterior composites when correctly indicated and executed the annual failure rate for composites may match or even surpass that of modern dental amalgam.[5-8]

It is safe to assume that amalgam has already reached its zenith in terms of clinical performance while the longevity of posterior composites is set to increase, albeit at an unknown rate. This will occur as more practitioners become proficient in

[1]Associate Professor, Department of Cariology and Endodontology, Radboud University Nijmegen, The Netherlands; [2*]Reader in Restorative Dentistry, The University of Birmingham, School of Dentistry, St Chad's Queensway, Birmingham, B4 6NN; [3]Department of Cariology and Endodontology, Radboud University Nijmegen, The Netherlands
*Correspondence to: Dr Adrian Shortall
Email: a.c.c.shortall@bham.ac.uk

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the correct selection and application of these materials through personal clinical experience and evidence based learning and as the materials and bonding agents are improved.

Longevity should not be the only way to look at a restorative material though this has always been the case with dental amalgam. Using dental amalgam the cavity preparation needed to be adjusted to meet the requirements of the material. Instead of this one should question in what way the tooth can be preserved as long as possible. Composite resin, glass ionomer cements and compomers do not require the more traditional preparation required for amalgam and adhesive restorative materials and techniques can be adjusted to all kinds of cavity shapes. As a consequence much less sound tooth tissue will be sacrificed. An *in vivo* study showed that when primary caries lesions in the occlusal surfaces of first molars were restored with amalgam the surface occupied by the restoration was five times larger than when a composite resin was used.[9] This means that a composite restoration can be replaced several times before the same amount of tooth material as with amalgam is lost. However, when composite resin restorations fail on the long term, there is no need to replace them completely as they can be repaired.[10] By doing this the 'tooth countdown' repeat restorative cycle is halted.[11] The total removal of bonded tooth coloured posterior restorations is more technically demanding and time consuming than for amalgam removal.[12] In addition, *in vitro* studies show that removal of bonded composite from class I and II cavities frequently results in significant sound tooth tissue loss which increases with increasing cavity depth.[12-15] Another important advantage of the adhesively bonded composite restoration is the reduced chance for cusp fracture compared to dental amalgam.[16] Complete cusp fracture or incomplete cusp fracture (cracked-tooth syndrome) is a common occurrence in clinical practice.[17,18] While different opinions exist as to whether direct or indirect adhesive and cusp-coverage restorations are best suited for restoring wide cavities in weakened posterior teeth[19,20] the effectiveness of using direct bonded composite in the immediate treatment of painful cracked teeth has been well documented.[20]

Manufacturers will hopefully optimise their materials/bonding systems in response to reliable clinical research data, which is the final arbiter of success. Unfortunately manufacturers are often driven by market forces to launch new products prematurely with exaggerated performance claims. By the time reliable independent research evidence is published showing that the product is inferior to its predecessor the manufacturer has usually discontinued it for a replacement material. This is not a 'practice builder' for the dentist who is left with the consequences of the under-performing product. Manufacturers may be driven to launch products prematurely in order to maintain or improve market share. This approach can prove to be shortsighted, as dentists have to rationalise the short-term failures of their restorations to an increasingly dentally aware public.

Expert group meetings have been proposed as one means of bridging the divide between the need for good evidence and the relentless challenge of the introduction of new products and concepts in the field of direct adhesive restorative materials.[21] In addition, the vast majority of clinical long-term published studies of direct posterior resin-based composite restorations are found lacking in their description of detailed operative techniques employed.[22] As reliable evidence about the clinical performance of new materials is generally not available as soon as required, it is the purpose of this multi-author paper to reflect international opinion from two countries where the uptake of posterior composites by the vast majority of practitioners is widely divergent. Composite is the most frequently used direct posterior restorative in the Netherlands[3] whereas in the UK the converse applies.[23] A 1999 survey of the work of vocational dental practitioners and their trainers revealed that amalgam was the most frequently used restorative with > 5 fold and > 10 fold the number of amalgams used for Class I and II restorations respectively in comparison to composites.[24] Also, a more recent survey concluded that 49% of respondents from Great Britain seldom place large composite restorations in molar teeth.[23] Differences in the system for health care remuneration in the two countries account, at least in part, for this difference. In addition, the UK data in question compared unfavourably, in terms of restoration longevity, in comparison to data from other European countries and Australia. It is hoped that the consensus view expressed in this paper, based on shared information and a collective interpretation of contemporary literature, will allow the reader to apply the knowledge in an informed fashion in order to allow him/her to choose appropriate materials and techniques for clinical practice.

Though all the indications can be covered with composite resin it is not obvious that this is achievable with a single material. Depending on the indication the restorative material should meet specific requirements. Composites vary in composition and handling characteristics and each of these factors will influence their clinical performance. Composite resins are composed of a resin matrix and filler particles. The type of resin will affect the viscosity of the resin and the amount of cross-linking but when properly polymerised it will not have a great effect on the mechanical properties of the material. Additions of filler particles to the resin improve the strength and wear resistance of the material while the polymerisation shrinkage of the restoration will be reduced. Based on the filler, composites can be classified in various ways. A classification based on filler size and loading was introduced in 1983:[25]

- Conventional composites with a filler particle size of 1 to 15 micrometer and filler content up to 60% by volume
- Microfilled composites with a filler size between 0.04 to 0.15 micrometer (or 40 to 150 nanometer) and filler content between 20 and 50% by volume
- Hybrid composites with a combination of microfillers and particles up to 5 micrometer and filler content between 50 to 70% by volume.

A classification based on the size of the largest particles has been presented as follows:[26]

- Microfills with a particle size between 0.01 to 0.1 micrometer.
- Minifills with a particle size between 0.1 and 1 micrometer.
- Midifills with a particle size of 1 to 10 micrometer.

Resin composites have also been classified to give more information about their filler content and filler distribution:[27]

- Traditional or conventional composites.
- Microfine composites
- Densified composites which can be midway-filled (< 60 vol.%) or compact-filled (> 60vol.%) while the filler size is described as ultrafine (< 3 micrometer) or fine (> 3 micrometer)
- Miscellaneous composites are a mixture of densified and microfine composites.

Recently 'nanofilled' composites comprising of nanomers (5-75nm particles) and nanocluster agglomerates have been marketed for dental use with different optical, mechanical and chemical properties to the more traditional micron-scale composites. Nanoclusters in all but translucent shades are agglomerates (0.6-1.4 micron size) of primary zirconia/silica nanoparticles (5-20nm size) fused together at points of contact and the resulting porous structure is infiltrated with silane. While initial short-term clinical findings appear promising[28] questions have been raised about the stability of the filler-matrix interface on the basis of short term immersion and *in vitro* fatigue stress testing.[29,30] The filler particles should be well bonded to the resin matrix as otherwise the material will be subject to deterioration and fatigue in the long term. Long-term clinical studies are required to assess fatigue resistance.

Another way to classify composites is according to the intended indication. There are anterior composites, posterior composites or universal composites that should be suitable for application in anterior and posterior teeth. Depending on the filler content, filler size, type of filler and type of resin, composites will vary in consistency or viscosity and rankings have been made of a number of composites based on their consistency.[31-33] In recent years composites with special handling properties have been marketed:

- Packable ('condensable') composites or ceromers are highly viscous materials designed to mimic the handling of a dental amalgam
- Flowable composites are materials that are low viscous or relatively fluid composites
- Conventional composites are materials that lie in between these two extremes. The materials in this group can be easily injected out of a compule and will readily adapt to the surface they are applied.

With the extensive range of currently available types (hybrid, microfilled, nanofilled, 'smart', fluoride releasing, etc) viscosities, shades, opacities and presentation formats (syringes, compules, complets etc) of composites it becomes difficult for the dentist to make a logical choice. Today, there is a tendency to bring highly viscous universal composites onto the market. At the same time several composites not belonging to this category but demonstrating excellent long term clinical performance (P30 and P50, 3M/ESPE) have been withdrawn from the market.[34-37]

The aim of this article is to define the specific requirements for each indication and to describe which material characteristics are needed to fulfil these. Furthermore, the influence of specific handling characteristics on the clinical performance will be discussed.

SPECIFIC REQUIREMENTS

There is a difference in the requirements a resin composite should meet to perform well in anterior or posterior teeth.

Restorations in anterior teeth

In the anterior region of the mouth restorations may fall inside the smile line and therefore the aesthetic properties of the resin composite will be of major importance. Resin composites can be used for class III, IV and V restorations, full veneers and complete crowns. Depending on the location on the tooth, restorations may be subjected to different forces.

The ideal anterior composite should meet the following demands:

- Must be available in a sufficient number of shades and degrees of translucency. To get a natural looking restoration, lost dentine should be replaced by an opaque composite while a more translucent material best mimics enamel. For optimal aesthetics under every condition the composite should also be able to exhibit fluorescence
- Capable of being readily polished to a lustrous finish. A smooth surface will be more comfortable and less vulnerable to extrinsic pigmentation. The polish should also be readily maintained in the long term.
- Colour stability must be good
- Should have sufficient strength to resist the forces of occlusion and articulation when class IV restorations or full veneers are made
- Easy to adapt to the tooth cavity and contour to shape.

Both hybrid and microfilled composites can be selected for anterior restorations. Traditionally microfilled composites are popular for anterior restorations. Due to the small size of the filler particles (0.04-1.5 micrometer) these composites have the smoothest surface. Due to the structure of the material the polish is readily maintained. Nevertheless microfilled composites also have some drawbacks. Due to the small size of the filler particles the filler content is rather low. As a result the resistance against fracture is low and the material is sensitive to fatigue.[38] Class IV microfill composite restorations frequently exhibit chip fractures at the incisal edge (Fig. 1).[39,40] Furthermore, the colour stability of microfilled composites is not so good. The high resin content of these materials is responsible for a continuous water absorption that not only affects the physical properties but also the colour stability.[41-42] In the case of a restoration that is subjected to heavy loads, a combination of a microfill with a backing of a stronger composite should be considered if aesthetic demands are critical.

Fig. 1 Chip fracture of a large class IV restoration

Whether hybrid composites are suitable for anterior restorations largely depends on the size of the filler particles. The smaller the average filler particle size is, the better the polish that may be obtained. When the average filler particle size is below 1 micrometer, the surface lustre (polish) that may be obtained is considered to be acceptable and these are the so-called submicron hybrid composites.

Especially for anterior teeth, the surface will not become smoother due to wear. Thus, appropriate finishing techniques are important. Wear will make the surface rougher in time and periodically polishing may be required. Advantages of the hybrid composites are the improved fracture resistance and good colour stability as the resin content is low compared with a microfill (Figs 2a, 2b, 2c, 2d).[43]

Restorations in posterior teeth

Most restorations in the occlusal surfaces of posterior teeth will be loaded directly and indirectly by occlusion and/or articulation. The resulting forces can be much higher

Fig. 2a Patient with an oblique incisal line and a palatally inclined upper right canine

Fig. 2b The canine was built up in a buccal direction and tooth 12 was lengthened with a hybrid anterior composite resin (Clearfil PhotoBright, Kuraray)

Fig. 2c Occlusal view after restoration

Fig. 2d The same restorations after 14 years. The restorations demonstrate less darkening than the natural dentition

than in anterior teeth. In general, restorations in molars are more stressed than in premolars. The critical requirements a resin composite for posterior restorations must meet are high fracture strength and wear resistance coupled with good radiopacity while the aesthetic properties are less important than in the anterior region. The visibility of restorations in occlusal surfaces is usually limited and in most cases a tooth coloured restoration will meet the aesthetic needs of the patient even when the tooth colour is not optimally reproduced. A slight shade mismatch between the restorative material and tooth can even be an advantage as margin finishing and recall inspection are simplified. A posterior composite available in a limited number of shades will satisfy most dentists and patients.

The ideal posterior composite should meet the following demands:

- Should be strong enough to prevent bulk fracture as this will require repair or replacement of the restoration. The strength of a resin composite will mainly depend on the filler content assuming a stable filler/matrix coupling. Composites with a filler content in excess of 65% by volume have high fracture resistance.[43] A high filler content will be accompanied by a relatively large average filler particle size as the smaller the filler particles are the more resin is needed to wet the particle surfaces. In an *in vitro* study evaluating the abrasion and attrition wear of a variety of composite materials the authors stated that the trend towards composites with smaller filler particles will result in materials with reduced mechanical properties.[44] Such materials will be prone to attrition and fracture. This statement is substantiated by clinical studies. An *in vivo* evaluation of indirect inlays and onlays made of a microfill composite showed that failure due to fatigue became evident after two to three years.[45] An eight year evaluation of class II restorations (Fig. 3) showed a significantly higher failure rate for a microfilled composite (Heliomolar) and a submicron hybrid composite (Herculite) than a heavily filled hybrid composite (P30).[46] In addition to the filler content, the modulus of elasticity can be used as an indicator for the fracture resistance of a resin composite. The modulus of elasticity reflects the ability to resist deformation and correlates well with filler load.[47] For a composite like Solitaire using a porous filler, high values are reported for the filler content – 90% by volume.[48] Then the modulus of elasticity can be used as an indication for the real filler content as an increase in filler content is accompanied by an increase in the modulus of elasticity. The modulus of elasticity of Solitaire I is lower than that of dentine and clinical and laboratory studies report a low fracture resistance for this material.[49] Restorations in posterior teeth are repeatedly loaded and the resulting deformation may lead to fatigue. Though it is often stated that composites should have a modulus of elasticity comparable with dentine (15-18 GPa) this can be questioned. Natural teeth are also composed of enamel that has a modulus of elasticity of about 80 GPa. Compared with enamel every resin composite resin can be considered as an elastic material. Heavily filled hybrid composites can have a modulus of elasticity of up to 25 GPa. The fracture resistance of such composites is the highest of all resin composites (Fig. 4).[43]
- Must not be sensitive to long term marginal breakdown. Many dentists consider marginal breakdown as a minor problem. However, according to at least one study there is a relationship between the quality of the marginal adaptation of posterior composite restorations and the risk of future failure.[50] The failure rates for restorations with marginal deterioration were generally higher than either the overall failure rates or the failure rates of restorations with sound margins. Restorations with marginal deterioration were between two to five times more likely to have failed five years after placement than restorations with sound margins. The incorporation of larger filler particles is advantageous for preventing marginal breakdown. When the margins of composite restorations are subjected to attrition wear, microfills (Heliomolar and Silux) and minifills (Z100 and Herculite) showed significantly more marginal breakdown than two midifills (Fulfil and Clearfil Posterior).[51] Marginal breakdown showed an excellent inverse correlation with fracture toughness for these composites. The midifills have an average particle size in excess of 1µm. Despite of the fact that they are hybrid composites the two minifills with an average filler particle size less than 1µm (in particular Z100) demonstrated large chip fractures parallel to the margins (Fig. 5).

Fig. 3 Fracture and marginal breakdown of a two-year-old class II restoration of a low E-modulus composite resin containing a polyglass filler (Quadrant Posterior Dense; Cavex)

Fig. 4 13-year-old MOD restorations in the premolars made with an ultrafine compact-filled composite resin (P30, 3M). Despite bulk discolouration there is little evidence of wear and marginal breakdown

Another possible explanation for the poor marginal behaviour of Z100 found in one study[51] is its sensitivity to hydrolytic degradation.[52,53] Other workers have studied the effect of chemical media on surface hardness of four composite restoratives.[53] Z100 appeared to be the most susceptible to softening after water storage. Z100 uses synthetic zirconia/silica fillers, which like other silica fillers have irregularly distributed Si-O-Si bonds. Swelling from water sorption by the resin matrix could induce stress around the stiff filler inclusions as a result of matrix expansion. The high energy level resulting from strained Si-O-Si bonds, makes the fillers more susceptible to stress corrosion attack causing complete or partial debonding of fillers which decreases hardness. These *in vitro* findings are supported by clinical studies. A three-year clinical evaluation of Z-100 in poste-

Fig. 5 Bulk fracture in a six-years-old large MOD restoration in tooth 24 restored with the ultrafine compact-filled composite resin (Z100, 3M)

rior restorations demonstrated marginal breakdown to be present in half of the restorations.[54] It is interesting to note that its successor Z250, while sharing the same filler type, but featuring a lower elastic modulus and a less hydrophilic resin matrix system has been reported as showing a failure rate of only 4% at four year recall in one clinical study of molar tooth restorations.[55] It will be interesting to see what longer term investigations reveal. In two clinical studies heavily filled hybrid composites (P50 and Clearfil Ray Posterior) showed better marginal adaptation after two years in service than a submicron hybrid composite (Herculite).[56,57] A three year clinical and indirect evaluation of three composites in class I and II restorations showed significantly more marginal breakdown for the microfill Heliomolar and the small particle hybrid Herculite than for the heavily filled particle P30 APC.[58,59]

- Should be wear resistant and not be too abrasive ('wear kind') to the antagonistic teeth. Some of the earliest posterior composites showed average occlusal wear of 100 to 150 microns per year.[59,60] Some current materials now exhibit at least 10 fold lower mean occlusal wear rates per year in contact-free occlusal areas (three-body wear) and appear to approach or match the wear resistance of dental amalgam at five year recall. However, wear rates increase three to five fold in occlusal contact (centric stops; two-body wear) areas and may be much higher still in bruxing patients.[61,62] While loss of proximal contacts was identified as the major cause for the high failure rate of Occlusin restorations at 10 year recall[62] no such failure pattern was noticed in a 10 year study of Visio-Molar radiopaque restorations.[63] These authors reasonably concluded that differences in materials and/or restoration cavity design may have accounted for the large difference seen in the failure rates/patterns. Wear of resin composites may result from abrasion and attrition. The wear resistance will increase with the filler content and when the filler is bonded to the resin phase by silanisation.[64] Wear is not only affected by the makeup of the restorative material but also by its union to tooth tissues. The available evidence suggests that wear is reduced when the restoration is bonded to the cavity walls.[65] Abrasive wear for different types of composite is not statistically different while attrition wear is higher for microfills and submicron hybrid composites than for heavily filled hybrids (Figs 6a, 6b).[44] Enamel wear will be less when the filler particles are silanised.[64] However, the opposing enamel will wear more against quartz and zirconium containing composites than against microfilled composites.[44] Another *in vitro* study demonstrated significantly more wear on the enamel side when the opposing material was a quartz-containing conventional hybrid than with submicron hybrid composites.[66] A 10-year clinical study on class II restorations demonstrated more wear for a submicron hybrid composite than for a heavily filled hybrid composites.[36] Indirectly assessed wear of the heavily filled hybrid composite Clearfil PhotoPosterior appeared to be very low after three years of clinical service.[67] The same material also had a high survival rate in a 10-year clincal evaluation.[37] In a study evaluating direct in- and onlays of a submicron hybrid composite the failure rate was higher in molars than in premolars but wear was not considered to be a problem.[68] Unacceptable wear was only recorded in patients who were bruxers. When extensive restorations are planned attention should also be paid to the possibility of abrading antagonistic teeth.

  The lower the polymerisation shrinkage the better it is as the shrinkage results in stress that may affect the bond.
- Must have good radiopacity to enable the diagnosis of dental caries on radiographs.

Handling characteristics

Resin composites are available in various consistencies and packages. Every dentist should select a material which s/he is comfortable with handling. In the last few years there is a tendency to bring materials on the market with an increased viscosity. Some materials are very stiff in consistency and are called packable composites or ceromers. In non-scientific articles based on information from the manufacturers, packables are seen as materials with improved handling and as the ideal alternative for dental amalgam in posterior teeth. The idea is given that these materials are not much different in handling from dental amalgam and that packing the composite results in good adaptation and a tight approximal contact.[69] Whether all packables are suitable alternatives for dental amalgam is questionable. It has been suggested that increased viscosity has been achieved by adding additional increments of filler or by using high molecular weight resins.[70]

Fig. 6a A large MOD preparation in tooth 36 was restored with an ultrafine midway-filled composite resin (Prodigy, Kerr)

Fig. 6b The 4-year-old restoration demonstrates generalised wear, discolouration and marginal breakdown

Packable dental composites do not have a significantly higher filler loading than non-packable composites. Rather, the higher viscosity and handling characteristics that are unique to this class of resin composites result principally from alterations of filler shape, size, or distribution.[71] Large differences in mechanical properties such as flexural strength, flexural modulus, fracture toughness and wear resistance appear to exist between various packable composites.[72] Other *in vitro* studies have concluded that packable composites appear to offer inferior or at best only equivalent properties compared to a conventional hybrid.[73-75] Finally, it has been concluded that packable composites are unlikely to offer improved clinical performance over well-placed non-packable composites.[75] Furthermore, they question the ability of clinicians to readily achieve tight interproximal contacts using packable composites. The quality of the approximal contact is determined by the matrix system and not by the consistency of the resin composite.[76] For some packables the manufacturer claims that the material is suitable for application and curing in bulk. *In vitro* studies have demonstrated that this is not the case and the requirement for effective polymerisation does not differ from conventional composites.[75,77] Most light-curing composites taken from a syringe contain some small porosities. For most composites these porosities become less after injecting.[78-80]

When using highly viscous composites porosities will increase due to a poor adaptation of such materials to the tooth surface and previously applied layers of composite.[81] In class I composite restorations significantly more voids and an imperfect wall adaptation were found for stiff composites and for composites applied by smearing and condensing instead of by an injection technique. The study was repeated with a group of six operators filling a small and a large class I cavity with a real packable or a medium viscosity composite that was injected.[82] Restorations were filled in two increments. All operators appeared to have more problems with handling the packable composite resin. Restorations made with the packable composite showed significantly more porosities and voids along the cavity wall and between the increments. Restoring small cavities without porosities appeared to be more difficult than restoring large cavities. Such porosities and voids can be sites for microleakage or may weaken the restoration. In an *in vitro* study simulating clinical handling samples were made with a stiff composite (Herculite) or a low viscous composite (P50).[83] Samples were made in bulk or in two layers. The layering technique resulted in a significantly lower flexural strength compared with the bulk samples. However, the decrease in flexural strength was significantly more for Herculite than for P50. Adaptation between layers appeared to be better for P50 than for Herculite where lines and voids were observed between increments. It is likely that such defects will reduce the resistance of a restoration against fatigue after repeated loading. The adaptation to the cavity wall of the highly viscous composites is a point of concern seeing the numerous studies in which flowables are used to improve the adaptation and to reduce microleakage. Whether the flowable will have a beneficial effect depends on the type of composite with which it is combined. When the resin composite is a very stiff packable a positive effect can be found on microleakage. Nevertheless, the microleakage is still more than for a conventional hybrid resin composite.[84] Sometimes the use of a flowable composite is advised to compensate for the poor performance of an adhesive system that produces a very thin layer that does not cure by itself due to oxygen inhibition.[85]

Application of a flowable is always an additional step in the restorative procedure, which can be avoided when a resin composite of lower viscosity and a good adhesive system is selected. Despite the general belief that flowable composite resins are easy to apply, several studies prove the opposite and report porosities and voids in the flowable composite.[84,86-87]

What the effect of a layer of flowable will have on margins under load is still unknown (Fig. 7). Loaded margins are prone to tensile fatigue and the physical properties of the flowables with their low filler content may be insufficient in the long term.

For anterior restorations a highly viscous composite will be more difficult to apply on the tooth surface. When building up the restoration in various shades there is an increased risk of porosities between the portions of composite. Marginal discolouration and surface porosity will have a negative effect on the aesthetics.

Fig. 7 A DO cavity in tooth 24 where flowable composite lining has pooled at the cervical cavity margin

The consistency of a composite also defines the mode of delivery. Composites can be available in a syringe or a predosed capsule or compule. Injecting the composite into the preparation will result in a reduction of porosities and voids. A prerequisite is the ability to place the end of the compule close to the bottom of the cavity. Stiff composites require a special design of the tip to be able to squeeze the material out. Therefore, the end of the tip must have a large diameter and this will prevent good access to small-sized cavities. Inserting the composite with a hand instrument will introduce even more imperfections in the restoration.[81]

DISCUSSION

During the last 10 years many new composites have been introduced. Most of these materials are marketed as universal composites. The first time such materials were introduced the argument that it was easy to work with just one material was valid. In those days composites were hardly used in stress-bearing restorations in posterior teeth, and if so, the size of the restorations was most of the time small to moderate. With the low frequency of posterior restorations there was a risk that posterior composites would have passed their shelf life before being used. Today, things have changed as composites are frequently applied in posterior teeth and are not limited to small restorations. Due to their filler content, universal composites will always be a compromise either to the aesthetics or strength. For the dentist who also wants to make long-lasting large composite restorations in posterior teeth they can be advised to choose a special posterior composite. Such a material should have a high filler content (65 to 70 vol%) and must have an average filler particle size larger than 1 micrometer. Preferably, such a material should be available in a well-designed compule to allow good access to small cavities. As compules are designed for single use only, compules containing various volumes of composites should be available to avoid wasting much material when small cavities are restored. As an alternative the dentist can decide to fill his/her own compules.

As the number of composite resins meeting these requirements has decreased over the last years, there is an important task for the manufacturers. Only with special resin composites for restorations in anterior and posterior teeth can the indications as mentioned a decade ago be optimally covered.[1]

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