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# Masters of Esthetic Dentistry

## Posterior Composites Revisited

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### INTRODUCTION

Although resin-based composites have been used to restore posterior teeth since the early 1970s,<sup>1–4</sup> the posterior composite technique has not been fully accepted in our profession. Recent advances in polymer chemistry and light-initiated polymerization systems have improved adhesives, composites, and light-curing, but concerns with composite wear, less than ideal bonding to dentin, polymerization shrinkage and related stresses, postoperative sensitivity, cost, and technique sensitivity still exist.

Given that the posterior composite technique has improved substantially since its introduction, and that it presents many advantages over alternative direct restorative materials (e.g., esthetics, adhesive properties), posterior composites are not as widely taught as one would expect. A survey of 54 dental schools in North America revealed that only 67% of them teach three-surface Class II composites in premolars, whereas only 60% teach two-surface Class II composites in molars.<sup>5</sup> Similar results were reported by another study recently published.<sup>6</sup> In part, this reluctance to incorporate posterior composites in the undergraduate curriculum reflects the lack of unanimous acceptance of the technique.

The purpose of this article is to briefly review the key aspects of the posterior composite technique, with emphasis on controversial, clinically related topics.

### WHAT ARE THE CURRENT INDICATIONS?

The most recent American Dental Association (ADA) Statement on Posterior Resin-Based Composites<sup>7</sup> endorses the use of posterior composites in (1) small and moderately sized restorations, (2) conservative tooth preparations, and (3) areas where esthetics is important. These include Classes I and II, replacement of failed restorations, and primary caries (Figures 1–4).

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*Figure 1. Preoperative occlusal view of tooth #19. The amalgam restoration presents with secondary caries on the lingual aspect. Note the gray aspect of the tooth structure adjacent to the restoration on the mesiolingual cusp.*



*Figure 2. Postoperative occlusal view of tooth #19 restored with composite. (Case completed with the assistance of Dr. Walter Dias.)*



*Figure 3. Preoperative occlusal view of tooth #13. The mesial and distal composite restorations show poor contour and secondary caries.*



*Figure 4. Postoperative occlusal view of tooth #13 restored with composite.*

Composites are a logical choice for primary caries cases where the lesion is not extensive. Because composites can be bonded, the requirements for retention and resistance form are not as stringent with composites as they are with amalgam. The more tooth structure that can be preserved during tooth preparation, the stronger the tooth

restoration unit. Therefore, tooth preparation for posterior composites can be limited to the removal of the carious enamel and dentin and the establishment of a convenience form for restoration.

The ADA Statement does not endorse the use of composites in (1) teeth with heavy occlusal stress,

(2) sites that cannot be properly isolated, or (3) patients who are allergic or sensitive to resin-based materials. Although patient allergic reactions to resin materials are rare,<sup>8</sup> patients with heavy occlusal stress are not uncommon. The concern is that, for these patients, composite wear rates are potentially higher than in patients with

well-equilibrated occlusion. If composites are used in these cases, it is critical to avoid occlusal contacts exclusively on the restoration.

Good moisture control is *sine qua non* when using posterior composites. This is best achieved with rubber dam isolation. Poor isolation results in deficient bonding and compromised composite placement.

Another important aspect related to the indication of posterior composites is the placement of the gingival margin in Class II restorations. For these restorations, the gingival margin is the most critical area in terms of marginal adaptation and microleakage. Studies show that the bond on gingival margins is not as effective as on axial and occlusal margins on Class IIs.<sup>9,10</sup> Although flowable composites might help (see the section on the use of flowable

composites later in this article), the presence of enamel is still the best assurance against leakage at gingival margins.<sup>11,12</sup>

The use of direct composites for building cusps is not recommended, although some studies suggest

that this is feasible in selected cases.<sup>13,14</sup>

#### HOW LONG DO POSTERIOR COMPOSITES LAST?

When properly placed, posterior composites can last many years (Figures 5–7). Several studies report



*Figure 5. Six-year postoperative occlusal view of teeth #17 and 18 with occlusal composite restorations (Charisma, Heraeus Kulzer, Hanau, Germany).*



*Figure 6. Twenty-year postoperative occlusal view of tooth #14 with an occlusomesial composite (Visiomolar, ESPE), and tooth #13 with a disto-occlusal composite (FulFil, Dentsply/Caulk, Milford, CT, USA). Photo courtesy of Dr. Harald Heymann, University of North Carolina School of Dentistry.*



*Figure 7. Twenty-eight-year postoperative occlusal view of tooth #14 with a moderately large occlusolingual composite restoration (Profile, SS White). Discoloration, marginal staining, and loss of anatomic form are evident, but the restoration is functional and still clinically acceptable to the patient.*

the clinical performance of posterior composites over time. Opdam and colleagues<sup>15</sup> recently published a retrospective study on the longevity of 1,955 posterior composites placed in a private practice setting. Life tables calculated from the data reveal a survival rate for composite resin of 91.7% at 5 years and 82.2% at 10 years. There was a significant effect of the amount of restored surfaces on the survival of the restorations—that is, the more conservative the restoration, the longer it survived. A number of other studies published in the past 10 years report success rates ranging from 70 to 100% for posterior composites.<sup>16–20</sup> These results were similar to those of a meta-analysis of studies conducted during the 1990s.<sup>21</sup> Very few clinical studies with evaluation periods longer than 10 years are available. A study by Wilder and colleagues<sup>22</sup> reported a 76% success rate for 85 ultra-violet cured posterior composites after 17 years, whereas da Rosa Rodolpho and colleagues<sup>23</sup> reported a 65% success rate for 282 hybrid visible-light cured composites after 17 years. The relatively low success rate reported in the latter study was attributed by the authors to the high number of large restorations placed.

Most clinical performance studies show that, in general, there is a linear correlation between the size of restoration and observation period and the number of failures,<sup>24</sup> which supports the recommendation that

posterior composites should be used in conservative, selected cases.

#### WHY DO POSTERIOR COMPOSITES FAIL?

The most commonly cited reasons for the failure of posterior composites in clinical studies are secondary caries, fracture, marginal deficiencies, and wear.<sup>15–24</sup> It should be noted that these reasons vary greatly depending on the type of study (randomized clinical trial versus private practice setting), type of composite used (ultra-violet cured, hybrid visible-light cured, etc.), period of observation, and other aspects of study design.

Although clinical studies do cite reasons for restoration failure, only a few studies discuss the predictive factors for future failure. Hayashi and Wilson demonstrated that marginal deterioration is a good predictor of failure.<sup>25</sup> By studying the data from a 5-year clinical trial on a posterior composite, they noted that restorations with marginal deterioration were 5.3 times more likely to have failed by 5 years than restorations with no marginal deterioration and that restorations with marginal discoloration at 3 years were 3.8 times more likely to have failed by 5 years than restorations with no marginal discoloration at 3 years. Moreover, restorations with both marginal deterioration and marginal discoloration at 3 years failed 8.7 times more frequently than restorations

with a sound margin at 3 years. In another report based on the results from the same study, these authors conclude that restorations with postoperative sensitivity in the large cavities were more likely to have failed by 5 years than restorations in the small cavities.<sup>26</sup>

In a study of 51 posterior composite restorations, where a 30% failure rate was reported at 5 years, Köhler and colleagues<sup>19</sup> demonstrated that 69% of the failures occurred because of secondary caries and marginal defects in patients with high counts of *Streptococcus mutans* at baseline, suggesting that patient factors such as caries activity and/or risk can influence the longevity of posterior composite restorations.

Resistance to wear has improved markedly in modern composites. Although early studies showed clinically important wear rates,<sup>27,28</sup> studies published more recently, in general, show clinically acceptable wear rates when posterior composites are used in conservative and moderately sized restorations.<sup>29,30</sup> It is believed that the improvement in wear resistance is due, in great part, to improvements in the material itself; but certainly, a better understanding of the posterior composite technique, along with improved light-curing techniques, has also helped. Willems and colleagues reported occlusal contact wear values of 110 to 149  $\mu\text{m}$  after 3



years,<sup>30</sup> whereas Wilder and colleagues reported wear values of 197, 235, and 264  $\mu\text{m}$  after 5, 10, and 17 years, respectively.<sup>22</sup> Given that the occlusal contact wear for enamel has been reported to be 15  $\mu\text{m}/\text{year}$  for premolars and 29  $\mu\text{m}/\text{year}$  for molars,<sup>31</sup> it appears that the yearly wear reported for posterior composites is similar to the reported enamel wear. However, wear may still be an important mode of failure for bruxers and clenchers, especially in large restorations.<sup>32</sup>

#### MATRIX SYSTEMS

Because composites are plastic, noncondensable materials, generating tight proximal contacts with composites is a challenge. Proper selection and placement of matrix systems for Class II posterior composites is important. For most

clinical applications, the use of a sectional, precontoured metallic matrix is preferred. Two recent studies demonstrated that posterior composite restorations placed with sectional matrices and separation rings resulted in a stronger proximal contact than when a circumferential matrix system was used.<sup>33,34</sup> The type of composite has been shown to have no influence on proximal contact strength.<sup>35,36</sup>

Figures 8 and 9 show one option for a matrix setup when placing a Class II posterior composite. Many similar sectional matrix systems are currently available.

#### BULK-FILLING TECHNIQUE AND POLYMERIZATION SHRINKAGE

Use of a single increment for posterior composites (the “bulk-fill” approach) is a controversial topic,

with studies showing favorable results,<sup>37,38</sup> and others showing negative results.<sup>39,40</sup> Single-increment composite placement requires high-intensity light-curing, and this placement technique has been linked to elevated shrinkage stress and margin problems.<sup>41,42</sup> Bulk placement also results in more marginal gap than incremental placement.<sup>40</sup> On the other hand, incremental placement is not unanimously accepted to control shrinkage stress.<sup>38,43,44</sup>

Most manufacturers still recommend that their composites be placed incrementally to maximize curing and minimize polymerization shrinkage. Incremental placement also allows for the development of proper anatomy following an anatomical placement technique<sup>45</sup> (Figures 10–20).



Figure 8. Occlusal view of tooth #28. A disto-occlusal composite restoration is being placed. The image shows the matrix setup with a precontoured sectional matrix band, wedge, and interproximal ring.



Figure 9. Occlusal view of tooth #3. An occlusomesial composite restoration is being placed. The image shows the matrix setup with a precontoured sectional matrix band, wedge, and interproximal ring.

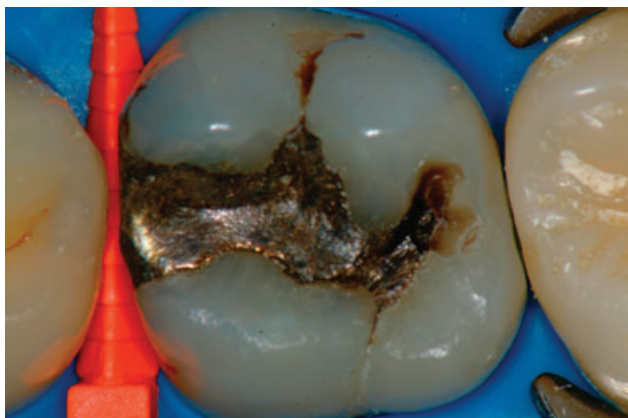


Figure 10. Preoperative occlusal view of tooth #3 with a deficient occlusomesial amalgam restoration. After administering local anesthetic, a rubber dam was applied and a wedge was firmly placed between teeth #3 and 4.

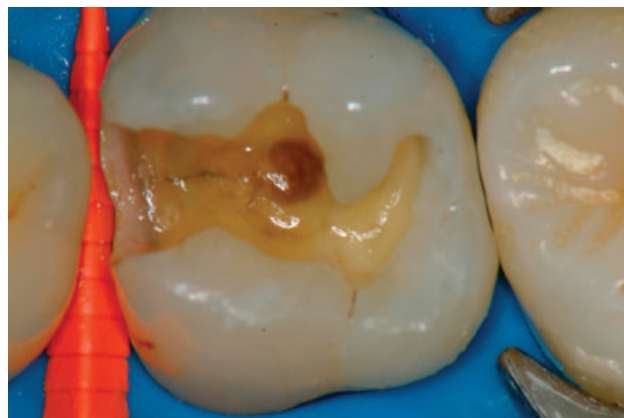


Figure 11. The amalgam restoration was removed. The extent of the preparation can be appreciated. Note the enamel on the mesial gingival margin.

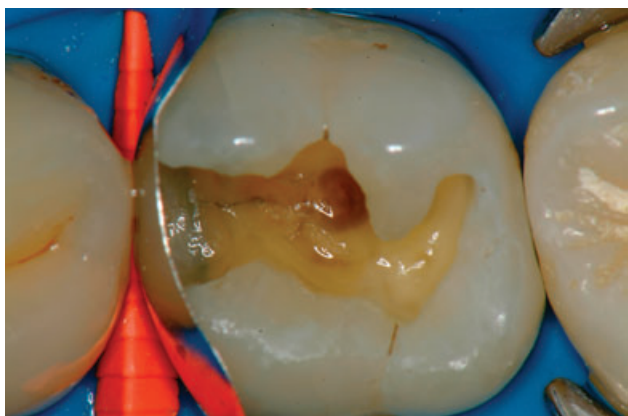


Figure 12. A precontoured sectional matrix is placed on the mesial box and secured with a wedge. (Because of the teeth being periodontally compromised, an interproximal ring was not used in this case.)



Figure 13. A two-step self-etching primer/adhesive (Clearfil SE Bond, Kuraray America, New York, NY, USA) is applied.



Figure 14. The mesial proximal box is completed first using an incremental placement and curing technique (Venus, Heraeus Kulzer, Hanau, Germany).



Figure 15. After the mesial proximal box is completed, the matrix and wedge are removed to facilitate access to the occlusal component of the restoration.



Figure 16. An anatomical layering incremental technique is used on the occlusal aspect of the restoration. The mesiolingual cusp is restored first.



Figure 17. The cusp inclines provide the best reference to develop the occlusal anatomy for the new restoration. The composite is “carved” following the anatomy of the tooth before it is cured.

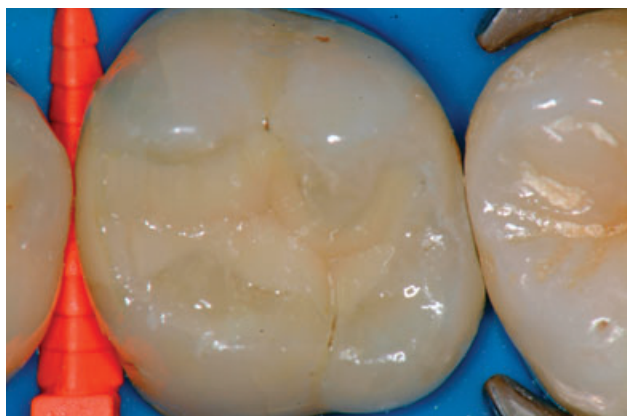


Figure 18. Occlusal view of the completed occlusal anatomy. When anatomical references such as the existing cusp inclines are used to develop the occlusal anatomy using the technique presented, finishing and occlusal adjustments are minimized.



Figure 19. Proximal embrasures are refined (and composite flash, if present, removed) with flexible finishing disks (Sof-Lex XT, 3M ESPE, St. Paul, MN, USA).



Figure 20. High-magnification occlusal view of the finished restoration.



One important drawback of composites is polymerization shrinkage. New low-shrinkage composites are on the verge of being introduced,<sup>46</sup> but as of today, all composites undergo measurable volumetric shrinkage upon curing, regardless of the curing method.<sup>47</sup> Consequently, significant amounts of stress can develop at the tooth-restoration interface when the composite is light-cured and soon thereafter, until the polymerization process is completed. Problems such as postoperative sensitivity, marginal enamel fractures, and premature marginal breakdown and staining can result from polymerization shrinkage stress. The polymerization shrinkage and the resultant stress can be affected by the (1) total volume of the composite material, (2) type of composite, (3) polymerization speed, and (4) ratio of bonded/unbonded surfaces or the configuration of the tooth preparation (C-factor).<sup>48–51</sup> Today, it is not possible to totally avoid polymerization shrinkage, but a careful insertion and curing technique can minimize the stresses resulting from this phenomenon.<sup>51,52</sup>

#### USE OF FLOWABLE COMPOSITES

The use of flowable composites as liners for posterior composite restorations is also a controversial topic. Flowable composites are (typically) hybrid composites with a

high matrix/filler ratio. Therefore, flowables are matrix-rich composites and, consequently, are relatively weak materials with elevated shrinkage rates.<sup>53,54</sup> When used in small amounts as liners, flowable composites have been shown by some to facilitate the posterior composite technique, reducing gingival margin leakage.<sup>55–58</sup> On the other hand, several studies show little or no benefit with the use of flowables under posterior composites.<sup>59–63</sup> Flowable composites can be used in very conservative preventive resin restorations, much like a filled sealant in minimally prepared pits and fissures.

An alternative to the use of flowable composites as liners is the use of resin-modified glass ionomers (RMGIs). RMGIs bond relatively well to dentin, and can be used to some extent as dentin-replacement materials in moderately deep preparations. RMGI used as a liner under posterior composites can serve as a stress breaker to minimize polymerization shrinkage stress.<sup>64–66</sup>

There is evidence that the use of an RMGI liner under a composite restoration in the root surface area may reduce potential microleakage, gap formation, and recurrent caries.<sup>67–71</sup>

In a study evaluating the clinical performance of 268 mostly extensive, open-sandwich, Class II RMGI and composite restorations,

46 failures were observed after 6 years. Significantly, more failures were recorded in high-carries-risk patients, which comprised approximately 50% of the patient population. The open-sandwich restorations showed an acceptable durability for the extensive restorations evaluated, but an accelerating dissolution of the RMGI was observed at the end of the study.<sup>72</sup>

#### POSTOPERATIVE SENSITIVITY

Controlled studies evaluating the clinical performance of posterior composites typically report a very low prevalence of (<5%), and only transient, postoperative sensitivity.<sup>73–76</sup> However, field reports (unpublished data) indicate that postoperative sensitivity is a problem for some clinicians. Postoperative sensitivity can be triggered by a number of factors, such as preoperative pulp status, tooth preparation technique (lack of irrigation during instrumentation, residual caries), and restorative technique (improper placement of materials, inadequate curing technique, high occlusion). It is also believed that postoperative sensitivity is highly related to the C-factor—that is, sensitivity can result from the inadequate management of polymerization stresses. Despite a general clinical perception, studies show that postoperative sensitivity is not related to the type of adhesive used—that is, total-etch versus



self-etch.<sup>77-79</sup> One recent study showed that preparation depth and the existence of short-term pulp complications were two critical predictors for the occurrence of long-term pulp complications.<sup>80</sup>

The apparent discrepancy between research data and field reports can be attributed to the conditions in which both groups operate. Clinical studies are usually done under ideal conditions, with patients (and teeth) carefully selected to match specific inclusion criteria and the restorations placed following a strict protocol. "Real-world" conditions may differ substantially from well-controlled study conditions. That is not to say that clinicians work under less-than-ideal conditions, but it simply provides a hypothesis for the discrepancy noted earlier.

Postoperative sensitivity can be minimized by the proper following of clinical protocol, which includes following the manufacturers' recommendations regarding the placement of adhesives and composites. One study shows that short-term postoperative sensitivity can be significantly reduced by a glass ionomer liner.<sup>81</sup> Use of liners and bases as pulp-protection materials is recommended when the remaining dentin thickness is less than 1 mm. Review of the causes of pulp injury and current concepts of pulp protection are available elsewhere.<sup>82,83</sup>

## CONCLUSIONS

Posterior composites can be used very predictably when (1) cases are well selected and (2) adhesives and composites are properly applied. This brief commentary/article reviews some key aspects of the posterior composite technique, with emphasis on topics that are perceived as controversial. The literature cited here could be useful if one wishes to have a more in-depth understanding of the topics presented.

## DISCLOSURE

The author has no financial interest in any of the products mentioned in this article.

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