Practice Paper

Failure of Composite Restorations: An Overview

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ABSTRACT

The use of resin composite as a material for restoring posterior teeth has continued to increase. Patients are attracted to a restoration that matches the color of natural teeth. Resin composite meets this demand and has become the most frequently used esthetic restorative material in dentistry. In addition, resin composites avoid the concerns over the use of mercury-containing materials, are thermally nonconductive, and bond to tooth structure with the use of adhesives. There are some problems associated with using resin composite in posterior restorations, however, including shrinkage that occurs on setting, occasional postoperative sensitivity, less-than-ideal resistance to wear, particularly if functional cusps are replaced with resin composite, and restoration fracture. Minimizing these negative aspects requires meticulous operative technique.

Keywords: Resin composite, adhesive, polymerization shrinkage, postoperative sensitivity, restoration fracture

INTRODUCTION

The use of resin composite as a material for restoring posterior teeth has continued to increase. Patients are attracted to a restoration that matches the color of natural teeth.[1] Resin composite meets this demand and has become the most frequently used esthetic restorative material in dentistry.[2,3] In addition, resin composites avoid the concerns over the use of mercury-containing materials, are thermally nonconductive, and bond to tooth structure with the use of adhesives.[4,5]

There are some problems associated with using resin composite in posterior restorations, however, including shrinkage that occurs on setting,[6]occasional postoperative sensitivity,[7,8] less-than-ideal resistance to wear, particularly if functional cusps are replaced with resin composite, and restoration fracture.[9–11] Minimizing these negative aspects requires meticulous operative technique. Along with appropriate case selection, it is one of the most important variables governing the success of posterior resin composite restorations.[12–14]

Although some questions about longevity remain, there is increasing evidence that properly accomplished posterior resin composite restorations can be quite durable.[10,15,16] Earlier studies comparing the clinical performance of amalgam restorations to resin composite restorations showed amalgam to last longer. Because studies are often of different duration, it is common to compute an annual failure rate (AFR) to allow a means of comparison. A review from the late 1990s found that high-copper amalgam restorations had an average 1.1% AFR as compared to 2.4% AFR for resin composite.[17] An analysis of more than 300,000 amalgam and resin composite restorations placed in posterior teeth and monitored during a 7-year period in private practices revealed that patients with resin composite restorations had a 16.4% greater chance of restoration failure than those with amalgam restorations at any time period in the analysis.[18] While this appears ominous for resin composite as a posterior restorative material, it should be noted that the probability of a posterior resin composite restoration surviving more than 5

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years (93%) differed little from that of an amalgam restoration (94%). More recently, a review of 2,780 Navy and Marine recruits who had satisfactory posterior amalgam or composite restorations upon entry into the military showed that there was a 64% greater risk of composite failure compared with amalgam failure over a period of 3 years.[19] A controlled clinical trial of 1,748 amalgam and composite restorations showed that amalgam had a significantly lower AFR (0.8%) than composite (2.2%) after 7 years.[20] This study also established that larger restorations had a higher failure rate compared with smaller restorations, regardless of restorative material. The risk for secondary caries was 3.5 times greater for composite restorations versus amalgam. However, a shift in the outcomes of clinical studies comparing amalgam with composite has taken place. Another controlled clinical trial of 1,262 restorations followed for 5 years found no significant difference in the clinical performance of amalgam (3.2% AFR) compared with composite (4.4% AFR). Similar to the previously mentioned clinical trial, larger restorations had a higher failure rate than smaller restorations.[21] Recently, long-term results in practice-based trials have been presented. A 10-year study of Class 1 and Class 2 restorations found no difference in the performance of amalgam (2.1% AFR) versus composite (1⁄8% AFR) restorations.[16] More recently, a 12-year trial of 1,949 large Class 2 restorations showed that composite performed significantly better (1.7% AFR) than a high-copper amalgam (2.4% AFR). In this study, patients who were considered to have a high caries risk had a significantly greater risk of restoration failure compared with low-caries-risk individuals. Furthermore, in the high-caries-risk patients, three-surface restoration longevity was significantly greater for the amalgam restorations, although there was no difference for four- and five-surface restorations.[22]

LONGEVITY OF POSTERIOR RESIN COMPOSITE RESTORATION

At the current stage of material development, it is not possible to say that resin composite is a true amalgam replacement capable of providing clinical service to the same level of performance in all of the same clinical situations as amalgam. However, with appropriate case selection and clinical technique, posterior resin composite restorations can serve very acceptably.

ADVANTAGES OF RESIN COMPOSITE

Esthetics

Manufacturers have developed sophisticated resin composite systems with multiple shades, tints and opaque resins that alone the practitioner to place highly esthetic restorations. [1]

Micro filled resins composite have the smoothest surface finished of all the systems and tend to stain less than other types.

Conservation of Tooth Structure

Researches today recommended a more conservative approach. The current design limits the removal of tooth structure to that needed to eliminate carious tooth and fragile enamel. There is no extension for prevention.

Adhesion to Tooth Structure

The bond between tooth structure and resin composite achieved with bonding structure offer the potential to seal the margins of restoration and reinforced remaining toot structure.[5]

Low Thermal Conductivity

Because resin composites do not readily transmit temperature changes, there is an insulating effect that may help to reduce postoperative sensitivity to thermal changes. [1,17]

Elimination of Galvanic Currents

Resin composite does not contain metal and so will not initiate and conduct galvanic current.

Radiopacity

Radiopaque restorative materials are necessary to allow the practitioner to evaluate the contours and marginal adaptation of the restoration as well as to distinguish among the restoration, caries lesions, and sound tooth structure. [11]

Alternative to Amalgam

Amalgam, despite having a long track record of clinical success, has declined in use as a restorative material primarily because of its unaesthetic appearance but also because of its mercury content.

DISADVANTAGES OF RESIN COMPOSITE

Polymerization Shrinkage

One of the major drawbacks of this material is the polymerization shrinkage that occurs during the setting reaction. Modern resin composites undergo volumetric polymerization shrinkage of 1.5% to 5%.[2,5,6,17] Most of the problems associated with posterior resin composite restorations can be related directly or indirectly to polymerization shrinkage and the streses that develops during polymerization. During polymerization, resin composite may pull away from the least retentive cavity margins (usually those with little or no enamel on them), resulting in gap formation.[1,5] Tensile forces developed in enamel margins can result in marginal degradation from mastication. Contraction forces on cusps can result in cuspal deformation, enamel cracks and craze lines and, ultimately, decreased fracture resistance of the cusps.

Postoperative Sensitivity

The most intriguing and challenging problem is post-operative dentin sensitivity, one of the disadvantages of using direct resin composites in posterior teeth.[5,17]

After restorations with resin composite, especially in posterior teeth, clinical observation has shown that patients complain of dentinal sensitivity at different levels and in different situations. This is a common problem, even with no visible failures in the restoration.

Pre-Operative Causes

- Cracks and fractures
- Cervical dentinal exposure
- Pulp condition

Operative Causes

- Abusive dental structure wear
- Incomplete carious tissue removal
- Negligence in protecting the dentin–pulp complex
- Inadequate isolation of the operative field
- Failure in dental tissue hybridization
- Handling restorative material

Post-Operative Causes

- Occlusal nterference

FAILURES OF COMPOSITE RESTORATIONS

Composites have become one of the most preferred esthetic restorations in modern times. But as they say “All that looks gold is not gold, even these restorations have their own hindrances.

Failures that can be seen in a composite restoration are as follows[1,2,5,17]

- Discolorations especially at margins
- Marginal fractures
- Recurrent Caries
- Gross fractures of restorations
- Lack of contact maintenance
- Post-operative sensitivity
- Pulpal irritation or damage
- Microleakage around composites

ASPECTS THAT INFLUENCE LONGEVITY OF COMPOSITE RESTORATION

1. Clinical factors
2. Operator factors
3. Patient factors
4. Socio economic factors
5. Material factors

Clinical Factors

Extra oral

- Moisture contamination from hand piece or air water syringe.
- Oil contamination of hand pieces or air water syringe.
- Presence of bases or liners on prepared teeth

Intra oral

- Salivary and or blood contamination
- Surface roughness of tooth surface.
- Mechanical undercuts in tooth preparation.
- Fluoride content of teeth
- Presence of plaque, debris, calculus, extrinsic strains or debris.
- Tooth dehydration

Operator Factors

It is generally acknowledged that the operator is probably the most important factor in the longevity of a dental restoration. A more conservative approach toward restoration replacement would, therefore, lead to increased restoration longevity. Technique-related aspects

of a posterior restoration rely on the knowledge and sufficient skills of the operator. In the past, dentists complained about difficulties in achieving adequate proximal contact when placing a posterior composite, and this was also found in a clinical study. Nowadays, techniques have evolved in that respect, and the operator can now use several types of matrices and separation rings that result in even tighter contact than before the treatment.[1,17] A relatively recent study on post-operative sensitivity found that this was mainly related to the cavity size and concluded that most sensitivity had disappeared over time. Some clinicians tend to make restorations of very high quality when it comes to the color and anatomy of the restoration. However, these restorations are never subjected to longevity evaluation, and it is unlikely that these esthetic quality aspects have any influence on posterior restoration survival in general. Moreover, these types of composite restorations, as inspiring they can be for the colleague dentist, are not feasible to place in everyday practice

Patient Factors

Although evidence is limited, it is likely that the type of patient and the oral environment play an important role in the survival of dental restorations. The caries risk of patients has been shown to significantly influence the longevity of restorations. Among the selected studies, several investigated the caries risk and found increased risk of failure of restorations placed in patients with high caries risk.[1,17] Restorations in a high-caries risk group had a failure rate more than twice as high compared to low-risk patients.

Material Factors

In vitro studies on the properties of resin composites for the restoration of posterior teeth have shown considerable differences among commercially available materials.

In vitro studies on the properties of resin composites for the restoration of posterior teeth have shown considerable differences among commercially available materials. Differences in flexural and compressive strength, elastic modulus, fracture strength and toughness, hardness, and wear resistance, among others, have been shown to be significantly different among materials when laboratory techniques were used to compare the restoratives.[1,814,16,17] Despite these considerable differences, which were usually considered to be a result of differences in organic matrix components, filler loading, or particle morphology/size, only minor differences in the clinical behaviour of composite restorations placed with different composite materials are often described in clinical studies.[5,8,14,16] A restriction in clinical trials is that long observation times are hardly feasible. As a result, most prospective clinical studies comparing different composites report short follow-up periods, showing no differences among the materials under investigation.

A recent retrospective study, however, has shown that, after 22 years, differences in filler characteristics between composites affected their clinical performance , as superior longevity was observed for a higher filler-loaded composite (midfilled) compared with a minifilled material when restorations were evaluated in the long term.[8,12,14,16] This study was the first to indicate that the physical properties of the composite may have some impact on restoration longevity. Fracture being the main reason for failure indicates that the midfilled composite, which has higher elastic modulus and hardness than the minifilled material, was less sensitive to long-term fatigue.[14,16] However, when the same population group was assessed after a 17-year follow-up, no significant differences among the materials could be observed, indicating that differences in clinical performance between composite materials with different properties may be significant only when the late failing behavior of composite restorations is taken into consideration. At the same time, it remains to be discussed whether these significant differences found after 22 years are relevant from the perspective of dental health care. Given the finding that, in most clinical studies, AFRs between 1% and 3% have been found for the composites used, one can speculate as to whether any relevant improvement in material properties can be made that would have a clinical impact. In other words, the resin composite materials for use in posterior teeth marketed in the last two decades may have a quality standard that is sufficient to fulfill the clinical requirements in most cases.

KEYS TO SUCCESS OF COMPOSITE RESTORATION

- Use the most conservative approach
- Routinely employ adhesive procedures
- Bevel the enamel margins
- Use a layering technique
- Obtain a proximal contact
- Restore functional occlusal and proximal anatomy
- Achieve good internal adaptation
- Create a good integration with periodontal tissue

CONCLUSION

Improved dental adhesive technology has extensively influenced modern concepts in restorative dentistry. The acid-etch technique for enamel bonding lead to the development of revolutionary restorative, preventive and esthetic treatment methods. Unlike bonding to enamel, bonding to dentin presents a much greater challenge due to its various complexities. While the bonding agents have made remarkable progress, each new generation has been characterized by new problems not previously exhibited by their predecessors. Improvements in dentin bonding materials and techniques are likely to continue. However, even as the materials themselves become better and easier to use, proper attention to technique and good understanding of bonding process remain essential for clinical success.

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REFERENCES

1. Summitt JB. Fundamentals of Operative Dentistry. 3rd Edition, Quintessence Pub., 2006.
2. Silikas N, Eliades G, Watts DC. Light intensity effects on resin-composite degree of conversion and shrinkage strain. Dent Mater 2000;16:292-6.
3. Causton BE, Miller B, Sefton J. The deformation of cusps by bonded posterior composite restorations: an in vitro study. Brit Dent J 2001;159:397–400.
4. Pearson GJ, Hegarty SM. Cusp movement in molar teeth using dentine adhesives and composite filling materials. Biomaterials. 2001;8:473-6.
5. Kakaboura A, Rahiotis C, Watts D, Silikas N, Eliades G. 3D-marginal adaptation versus setting shrinkage in light-cured microhybrid resin composites. Dent Mater 2007;23:272-8.
6. Feilzer AJ, Dooren LH, de Gee AJ, Davidson CL. Influence of light intensity on polymerization shrinkage and integrity of restoration-cavity interface. Eur J Oral Sci 2005;103:322-6.
7. Ferracane JL, Antonio RC, Matsumoto H. Variables affecting the fracture toughness of dental composites. J Dent Res 2007;66(6):1140–1145
8. Braem M, Finger W, Van Doren VE, Lambrechts P, Vanherle G. Mechanical properties and filler fraction of dental composites. Dent Mater 2009;5:346-9.
9. Kim KH, Park JH, Imai Y, Kishi T. Microfracture mechanisms of dental resin composites containing spherically-shaped filler particles. J Dent Res 2004;73:499–504.
10. Söderholm K-JM. Influence of silane treatment and filler fraction on thermal expansion of composite resins. J Dent Res 2004;63:1321-6
11. van Dijken JWV, Wing KR, Ruyter IE. An evaluation of the radiopacity of composite restorative materials used in Class I and Class II cavities. Acta Odontol Scandinavica 2009;47:401-7.
12. Cavalcante LM, Masouras K, Watts DC, Pimenta LA, Silikas N. Effect of nanofillers' size on surface properties after toothbrush abrasion. Am J Dent 2009;22:60-4
13. Baroudi K, Silikas N, Watts DC. Time-dependent visco-elastic creep and recovery of flowable composites. Eur J Oral Sci 2007;115:517-21.
14. Kim K-H, Ong JL, Okuno O. The effect of filler loading and morphology on the mechanical properties of contemporary composites. J Prosthet Dent 2002;87:642-9.
15. Rodrigues SA, Jr., Scherrer SS, Ferracane JL, Della Bona A. Microstructural characterization and fracture behavior of a microhybrid and a nanofill composite. Dent Mater 2008;24:1281-8.
16. Masouras K, Silikas N, Watts DC. Correlation of filler content and elastic properties of resin-composites. Dent Mater 2008;24:932-9.
17. Van Noort R. Introduction to Dental Materials. 3rd edition. London, UK: Elsevier; 2007.
18. Mitra SB, Wu D, Holmes BN. An application of nanotechnology in advanced dental materials. J Am Dent Assoc 2003;134:1382-90.
19. Asmussen E, Peutzfeldt A. Influence of UEDMA, BisGMA and TEGDMA on selected mechanical properties of experimental resin composites. Dent Mater 2008;14:51-6.
20. Ferracane JL, Greener EH. The effect of resin formulation on the degree of conversion and mechanical properties of dental restorative resins.

J Biomed Mater Res 20066;20:121–31.
21. Sideridou I, Tserki V, Papanastasiou G. Effect of chemical structure on degree of conversion in light-cured dimethacrylate-based dental resins. Biomaterials 2002;23:1819-29.
22. Moszner N, Salz U. New developments of polymeric dental composites. Progress in Polymer Science 2001;26:535–76.

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