



Packable Resin Composites

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Introduction

Increased demand by patients and clinicians for esthetic restorations coupled with the public's concern about mercury have resulted in an escalating use of resin composite materials (1). Resin composite is now often utilized to restore tooth surfaces previously accomplished with silver amalgam. Packable (a.k.a. moldable or condensable) resin composites are the product of vast amounts of research money and time focused on the development of a resin-based amalgam substitute with sufficient physical properties to withstand posterior occlusal forces. Unfortunately, clinical and laboratory data are mixed concerning the long-term success of packable resin composite restorations. This paper will discuss some of the physical properties of packable resin composites and indications and contraindications for their use.

Mechanical and physical properties

Packable resin composites possess the same advantages other resin composites have over silver amalgam such as low thermal conductivity, the ability to be bonded to tooth structure, absence of galvanic currents, and esthetics. Manufacturers' market packable resin composites suggesting they can be placed in bulk, have less polymerization shrinkage, decreased microleakage, and increased fracture toughness and wear resistance compared to traditional hybrid composites. However, research does not support all of these claims.

Polymerization. Traditional light-cured hybrid resin composites cannot be bulk placed because of excessive polymerization shrinkage and the inability to adequately light-polymerize the resin beyond a 2mm depth. Manufacturers prescribe bulk placement of packable composites claiming decreased polymerization shrinkage due to increased filler loading and a reported depth of cure reaching 5mms. However, certain packable resin composites demonstrated polymerization contraction similar to or higher than conventional hybrid composites (2). The completeness of polymerization of some packable resin composites was significantly less with bulk cure in comparison to standard incremental polymerization (3).

Microleakage. Increased viscosity and filler particle content requires more force and increases the difficulty to adapt the resin composite to the cavity wall. Stiffness of the material has been shown to be directly proportional to microleakage. The stiffness and inability to flow during the polymerization process might cause increased polymerization stresses to form accounting for the increased contraction and microleakage (1). Using a flowable restorative resin composite liner has been recommended to compensate for the increased microleakage. Flowable resin used under packable composite improves adaptation to cavity walls and decreases microleakage at both enamel and dentin margins (1,4). However, the technique is linked to a decrease in strength of the final restoration (5).

Fracture Toughness. The fracture toughness for packable composites is product specific. Some packable resin composite materials have demonstrated fracture toughness greater than hybrid composites and others significantly lower (6). Resistance to crack propagation can be related to fracture strength and micro-hardness and is important in resisting catastrophic failure of the composite over time (7). The increase in filler particle load in packable composites demonstrated a weak correlation to the resistance to microfractures (6). Fracture strength was similar for packable and nonpackable composites (2,8). Microhardness varies among packable resin composites and is in the range of nonpackable resin composites (2). There is little evidence that packable resin composites as a group are stronger and better able to withstand occlusal forces of mastication.

Wear resistance. Historically occlusal wear has been a major concern with posterior composites. Microfilled resin composites initially developed for posterior restorations exhibited poor long term wear to attrition with wear resistance rates significantly less than conventional hybrid resin composites (9,10,11). Brackmier et al. (11) demonstrated that the least localized wear occurs with the nonpackable resin composites compared to packable resin composites.

Other Factors. Elasticity of packable resin composites differs greatly (12). Ideally it should be similar to the elasticity of dentin. The smaller the difference in elasticity between the restorative material and dentin the less marginal breakdown is expected to occur (13).

Packable resin composites were unable to improve cuspal stiffness anymore than conventional resin composite or amalgam restorations (14). Cuspal deformation of packable resin composite was similar to that of hybrid composite (15). Silver amalgam, indirect cast metal, and ceramics are still the restorative materials of choice for larger posterior restorations with faciolingual dimensions greater than one-third the intercuspal width (14).

Many operators are used to the handling characteristics of amalgam and want a material that handles and performs similarly. Nash (17) reported that placing packable resin composites does not feel the same as condensing amalgam even with the increase in filler particle load. One of the primary reasons for increasing the filler loading was to meet this demand. Packable resin composites are not as sticky as conventional resin composites thus decreasing adherence to instruments (9,16). The increased stiffness may allow for a proximal contact to be formed more easily and be maintained prior to, during, and after polymerization (2). The ability to maintain a tighter interproximal contact is important to Class II restorations. Smaller interproximal gaps are formed with packable resin composites compared to hybrid resin composites. However, silver amalgam still produces the tightest interproximal contacts (16).

Packable resin composites have some physical properties superior to microhybrid resin composites but are not significantly better at

restoring posterior teeth (8). More *in vivo* long-term data are needed to determine if packable resin composites are ultimately better than hybrid resin composites for posterior restorations. Lienfelder et al. (9) concludes based on mechanical properties alone that packable resin composites do not yet equal silver amalgam and are not a substitute in all situations.

Indications and Contraindications

Packable resin composites were developed to restore surfaces that previous resin composites could not. However, certain principles still hold true. The need for an esthetic restoration should be one of the major indications. The faciolingual width of the cavity preparation should be no larger than one-third the intercuspal distance and replacement of cusps with packable resin composite is contraindicated (18,19). A class II restoration should ideally end on sound enamel (18). If enamel is not present at the cervical margin other procedures such as an "open sandwich technique" should be used. In this procedure, glass ionomer is placed as the initial increment filling the first couple of millimeters of the box. Glass ionomer's predictable bond to dentin reduces microleakage compared to a resin-dentin margin (20,21). Centric stops should be on tooth structure (18,19,22). Clinical signs of excessive wear of bruxing and grinding should be absent (21). One of the most critical factors for long-term success is the ability to isolate with a rubber dam (18,19). Avoiding saliva and blood contamination of the prepared enamel and dentin surfaces is vital to achieving a proper bond (18,22). Packable resin composite should not be viewed as a time saver as bulk placement of packable resin composite is not recommended and may compromise the long-term success of the restoration.

Conclusions

The introduction of packable resin composites provides another option for the restoration of posterior teeth. They were introduced with the goal of producing handling characteristics similar to amalgam; however, the mechanical properties are still more similar to microhybrid resin composites (10). Currently, numerous packable resin composites are marketed with differing mechanical properties (2,6,12). Careful product selection is necessary due to the wide variation (2,3,6,12). Excellent isolation, meticulous placement, and specific procedures and techniques (open sandwich) are advised. Packable resin composites are not likely to improve the long-term success over a well done microhybrid resin composite. Silver amalgam is still the gold standard for large posterior restorations.

References

1. Leevailoj C, Cochran MA, Matis BA, Moore BK, Platt JA. Microleakage of posterior packable resin composites with and without flowable liners. *Oper Dent*. 2001 May-Jun;26(3):302-7.
2. Choi KK, Ferracane JL, Hilton TJ, Charlton D. Properties of packable dental composites. *J Esthet Dent*. 2000;12(4):216-26.
3. Manhart J, Chen HY, Hickel R. The suitability of packable resin-based composites for posterior restorations. *J Am Dent Assoc*. 2001 May;132(5):639-45.
4. Tung F, Estafan D, Scherer W. Microleakage of a condensable resin composite: an *in vitro* investigation. *Quintessence Int*. 2000 Jun;31(6):430-4.
5. Rashid R, Ricks J, Monaghan P. Strengths of condensable resin composite with flowable liners. *Dent Mater*. 1999;78:156 Abst No. 403.

6. Bonilla ED, Mardirossian G, Caputo AA. Fracture toughness of posterior resin composites. *Quintessence Int*. 2001 Mar;32(3):206-10.
7. Roulet JF. The problems associated with substituting composite resins for amalgam: a status report on posterior composite. *J Dent*. 1988 Jun;16:101-13.
8. Cobb DS, MacGregor KM, Vargas MA, Denehy GE. The physical properties of packable and conventional posterior resin-based composites: a comparison. *J Am Dent Assoc*. 2000;131(11): 1610-5.
9. Leinfelder KF, Bayne SC. Packable Composites: overview and technical considerations. *J Esthet Dent*. 1999;11;5:234-49.
10. Ruddell, Thompson JY, Stamatiades PJ, Ward JC, Bayne SC Shellard ER. Mechanical properties and wear behavior of condensable composites. *Dent Mater*. 1999;78:156 Abst No. 407.
11. Barkmeier WW, Wilwerding MA, Latta MA, Blake SM. *In-vitro* wear assessment of high density resin composites. *J Dent Res*. 1999;78:448 Abst No. 2737.
12. Abe Y, Lambrechts P, Inoue S, Braem MJ, Takeuchi M, Vanherle G, Van Meerbeek B. Dynamic elastic modulus of 'packable' composites. *Dent Mater*. 2001 Nov;17:520-25.
13. Willems G, Lambrechts P, Braem M, Celis JP, Vanherle G. A classification of dental composites according to morphological and mechanical characteristics. *Dent Mater*. 1992 Sep;8:310-9.
14. Molinaro JD, Diefenderfer KE, Strother JM. The influence of a packable resin composite, conventional resin composite and amalgam on molar cuspal stiffness. *Oper Dent*. 2002 Sep-Oct;27(5):516-24.
15. Rooklidge B, Boyer D, Bouschlicher M. Cusp deformation by shrinkage of condensable composites. *Dent Mater*. 1999;78: Abst No. 2349.
16. Bagby MD, House RC, Baier RL, Helms SK, Tatich DJ. Interproximal contacts of packable composites. *J Dent Res*. 2000;79:448 Abst No. 2440.
17. Nash RW, Lowe RA, Leinfelder K. Using packable composites for direct posterior placement. *J Am Dent Assoc*. 2001 Aug;132(8):1099-104.
18. Ferracane JL. Using posterior composites appropriately. *J Am Dent Assoc*. 1992 Jul;123:53-8.
19. ADA Council on Scientific Affairs, ADA Council on Dental Benefit Programs. Statement on posterior resin-based composites. *J Am Dent Assoc*. 1998;129:1627-1628.
20. Aboushala A, Kugel G, Hurley E. Class II composite resin restorations using glass-ionomer liners: microleakage studies. *J Clin Pediat Dent*. 1996 Fall;21:67-71.
21. Miller MB, Castellanos ER, Vargas MA, Denehy GE. Effect of restorative materials on microleakage of Class II composites. *J Esthet Dent*. 1996;8:107-13.
22. Leinfelder KF. Using a composite resin as a posterior restorative material. *J Am Dent Assoc*. 1991 Apr;122:65-70.
23. Warren JA, Clark NP. Posterior composite resin: current trends in restorative techniques. Part I. Pre-preparation considerations, preparation, dentin treatment, etching/bonding. *Gen Dent*. 1987 Sep-Oct;35:368-72.

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