

Remaining challenges with Class II resin-based composite restorations

Class II resin-based composite restorations continue to grow in use and popularity. It has been my observation from polling participants of continuing education courses that many dentists do not include any amalgam restorations in their practices, and that the use of posterior tooth-colored restorations is different from country to country and in different economic groups of patients. A survey showed that 68 percent of respondents in the United States and Canada still use amalgam at least part of the time in their practices.¹ Other surveys state that amalgam is still a major treatment alternative.²⁻⁴ Amalgam use is not declining rapidly.

Many patients prefer to have tooth-colored restorations instead of metal restorations. I have watched the evolution in the profession from metallic restorations to tooth-colored restorations. I was a participant in an informal clinical study of Class II resin-based composite restorations that began in 1968, accomplished via clinical study

clubs in Denver and Idaho Falls, Idaho. This study compared Adaptic (Johnson & Johnson, New Brunswick, N.J.), a popular brand of resin material then being promoted for use in Class II locations, with amalgam. Some of the Class II resin restorations placed in that study 40 years ago still are serving. However, study club members have informed me that the majority of the early resin-based composite restorations from the study have failed, and many of the amalgam restorations used as controls still are serving.

Do the improvements in resin-based composite since the late 1960s allow this clinical concept to become the major restorative procedure for tooth restorations, and is it a viable alternative to the long-proven amalgam restoration? What positive changes have occurred in the past 40 years in resin-based composite materials and techniques?

In this column, I will express my observations and describe some of the research regarding the current state of Class II resin restorations. I also will

address the changes needed in materials and techniques to improve the service potential of this type of restoration.

STRENGTH AND RETENTION OF SURFACE SMOOTHNESS ACROSS TIME

The filler particles in resin-based composite materials have been changed and improved significantly since their introduction in the early 1960s.

Although the resin formulation has remained as bisphenol A glycidyl dimethacrylate and modifications of that resin chemistry, the fillers in the resin-based composite have been changed significantly. In the years since the introduction of the resin-based composite concept, filler particle size has been decreased, and the filler composition has been modified. Currently, most resin-based composite materials have glass filler particles with a mean size ranging from 0.4 micrometers or 400 nanometers to 0.6 μm or about 600 nm, surrounded by silicon dioxide particles that are smaller than 100 nm in size. These so-called microhybrid resins can be polished initially to a beautiful smooth surface. However, it is well-known among practitioners that the

Gordon J. Christensen, DDS, MSD, PhD

highly finished and polished surfaces of the microhybrid restorative materials from almost all companies become slightly rough and dull in appearance during a short service period. Therefore, they accumulate stains from pigmented foods and drinks, tobacco and other pigmented materials placed in the mouth. Silicon dioxide filler particles, with a size usually ranging from 40 to 100 nm, have been used in microfill restorative materials (such as Durafill [Heraeus Kulzer, Armonk, N.Y.] and Heliomolar [Ivoclar/Vivadent, Amherst, N.Y.]). Contrary to microhybrid materials, microfill resin-based composites have retained their polished surfaces well across time, but they are well-known among practitioners to have only moderate strength, occasionally experiencing fracture during service when placed in stress-bearing areas.

A recent entry in the market is a one-of-a-kind product, Filtek Supreme Plus (3M ESPE, St. Paul, Minn.), which contains a filler consisting of small zirconium oxide spheres (20-70 nm) sintered together. In short-term clinical research, the material has exhibited both smoothness and strength, characteristics attributable to the extremely small size and the strength of the zirconium oxide nanofill filler particles.⁵⁻⁸ It is apparent that when placed properly, the current generation of resin-based composites has strength properties high enough to serve in the posterior part of the mouth without breakage, and that some brands retain their surface smoothness during service, allowing them to be adequate from an esthetic standpoint. Numerous products

are demonstrating those clinical characteristics.

I suggest that manufacturers seek fillers that allow their products to retain surface smoothness across the service period expected of the restorations and not just at initial finishing. Although advertisements for composites often claim long-term smoothness, it is well-known among practitioners that most microhybrid brands become rough during service, collecting unsightly stains, developing surface degradation and appearing dull and rough to patients and other observers.

SHRINKAGE DURING POLYMERIZATION

Most resin-based composites shrink about 2 percent during polymerization. The result is that resin-based composite, bonded to enamel and dentin, produces residual stress and strain in the teeth into which it has been placed.⁹⁻¹³

Does 2 percent polymerization shrinkage cause clinical problems? Overall, it appears that this level of shrinkage is not a major problem. However, there are potential negative effects from stress in the remaining tooth structure. Most dentists have observed the development of a “white line” that appears on the marginal areas of teeth during final finishing procedures, especially on the occlusal surfaces of Class I and II restorations. Some have postulated that this line occurs because of the stress that is released in the tooth by the trauma caused during finishing and polishing procedures. Therefore, I believe that manufacturers should seek to reduce the polymerization shrinkage of resin-based composites to mini-

mize stress in remaining tooth structure and thereby reduce the potential production of the unsightly and potentially caries-prone “white line” during finishing.

WEAR DURING SERVICE

Significant premature wear was a major negative characteristic early in the development of these materials, as explained by the well-known “plucking phenomenon.” As the large filler particles were released due to wear of the resin matrix, microscopic rough holes were formed, causing what appeared collectively to be wear of the overall restoration. However, with improved smaller filler particles, wear has been reduced markedly during the past many years to the level that some of the materials intended for Class II use wear to a degree similar to that of enamel.^{14,15}

Manufacturers should seek to produce resin-based composite materials that wear as similarly to enamel as possible. This characteristic, if achieved, would preclude the collapse of occlusion with wear, as composite material would wear at the same rate as does enamel. If unequal wear of the natural tooth compared with the restoration occurs, the maxillary and mandibular teeth collapse into one another, causing non-working and working interferences, tooth breakage and, potentially, temporomandibular joint dysfunction.

POSTOPERATIVE TOOTH SENSITIVITY

Every dentist has had patients who have experienced unpredictable postoperative tooth sensitivity after receiving Class II resin-based composites.¹⁶ This

frustrating situation was a severe problem early in the use of Class II resin restorations. When a simple restoration placed in a minimally prepared tooth with Class II caries produces unbearable postoperative tooth sensitivity that requires endodontic therapy and hundreds of dollars' worth of subsequent treatment, patients are rightfully upset.

Practitioners have observed that either of the following techniques reduces or eliminates the postoperative tooth sensitivity problem:

- Use a resin-modified glass ionomer (such as Vitrebond, 3M ESPE, or Fuji Lining Cement, GC America, Alsip, Ill.) as a thin (approximately 0.5-millimeter) liner before placing the dentin bonding agent. This technique greatly reduced postoperative tooth sensitivity.¹⁷

- Place a dentin bonding agent and then a thin (again, approximately 0.5-mm) layer of flowable resin-based composite over the bonding agent before placing the restorative resin.

It appears that in spite of the occasional postoperative tooth sensitivity problem that still is present among restorations placed by inexperienced practitioners, this unfortunate condition now is preventable when either of the preceding techniques is used.

OPEN CONTACT AREAS

Another annoying problem for neophyte clinicians has been the inability to produce tight, properly contoured contact areas routinely. Most experienced dentists have solved this problem by using sectional matrices. Among the brands of sectional matrices are Composi-Tight Silver Plus and other variations of the same

matrix (Garrison Dental Solutions, Spring Lake, Mich.), V-Ring System (TrioDent, Katikati, New Zealand) and Contact Matrix (Danville Materials, San Ramon, Calif.).

SUMMARY

The remaining challenges with some types and brands of Class II resin-based composite include surface roughness and a dull appearance that occurs during service, polymerization shrinkage that occurs during curing, and restoration wear during service that is more than the wear of enamel. All three of these conditions have minor-to-moderate observable negative clinical effects and need to be reduced or eliminated. Unpredictable postoperative tooth sensitivity and open contact areas can be overcome with the techniques I discuss in this article.

I predict that Class II resin-based composite materials gradually will replace other restorative materials, mainly amalgam, for routine use in posterior tooth restorations. I encourage manufacturers to direct their energies and research creativity to overcoming the remaining challenges inherent in resin-based composite materials. I encourage clinicians to use the known procedures that will optimize the ability of resin-based composite to serve symptom-free and with characteristics acceptable in the long term. ■

Dr. Christensen is the director, Practical Clinical Courses, and co-founder and senior consultant, CRA Foundation, Provo, Utah. He also is the dean, Scottsdale Center for Dentistry, Scottsdale, Ariz. Address reprint requests to Dr. Christensen at CRA Foundation, 3707 N. Canyon Road, Suite 3D, Provo, Utah 84604.

The views expressed are those of the author and do not necessarily reflect the opinions or official policies of the American Dental Association.

1. Clinical Research Associates. Clinicians' Preferences 2005:survey data from 1652 random CRA Newsletter subscribers. CRA Newsletter 2005;29(10):3.
2. Guelmann M, Mjör IA, Jerrell GR. The teaching of Class I and II restorations in primary molars: a survey of North American dental schools. *Pediatr Dent* 2001;23(5):410-4.
3. Lynch CD, McConnell RJ, Wilson NH. Trends in the placement of posterior composites in dental schools. *J Dent Educ* 2007;71(3):430-4.
4. Pair RL, Udin RD, Tanbonliong T. Materials used to restore class II lesions in primary molars: a survey of California pediatric dentists. *Pediatr Dent* 2004;26(6):501-7.
5. Mitra SB, Wu D, Holmes BN. An application of nanotechnology in advanced dental materials. *JADA* 2003;134(10):1382-90.
6. Lopes GC, Zucco J, De Lucca C, Baratieri L, Vieira L. Diametral tensile strength of micro-hybrid composite resins (abstract 0585). Paper presented at: International Association for Dental Research and American Association for Dental Research 82nd General Session; March 11, 2004; Honolulu.
7. Lu H, Lee Y-K, Oguri M, Powers JM. Mechanical properties of dental resin composites (abstract 1845). Paper presented at: International Association for Dental Research and American Association for Dental Research 83rd General Session; March 11, 2005; Baltimore.
8. Wu D, Holmes BN, Mitra SB, Kolb BU, Thompson W, Johnson N. Toughness and strength properties of novel dental nanocomposites. Paper presented at: First Meeting of the Pan-European Federation of the International Association for Dental Research; Cardiff, Wales; Sept. 25-28, 2002.
9. Alomari Q, Ajlouni R, Omar R. Managing the polymerization shrinkage of resin composite restorations: a review. *SADJ* 2007;62(1):12, 14, 16 passim.
10. Cabrera E, de la Macorra JC. Polymerization shrinkage influences microtensile bond strength. *J Dent Res* 2007;86(3):227-31.
11. Ellakwa A, Cho N, Lee IB. The effect of resin matrix composition on the polymerization shrinkage and rheological properties of experimental dental composites. *Dent Mater* 2007;23(10):1229-35.
12. Charton C, Colon P, Pla F. Shrinkage stress in light-cured composite resins: influence of material and photoactivation mode. *Dent Mater* 2007;23(8):911-20.
13. Zanchi CH, de Carvalho RV, Rodrigues SA Jr., Demarco FF, Burnett LH Jr. Shrinkage stress of three composites under different polymerization methods. *Braz Oral Res* 2006;20(2):137-42.
14. Lutz F, Krejci I, Barbakow F. Chewing pressure vs. wear of composites and opposing enamel cusps. *J Dent Res* 1992;71(8):1525-9.
15. Hickel R, Manhart J, Garcia-Godoy F. Clinical results and new developments of direct posterior restorations. *Am J Dent* 2000;13(special no.):41D-54D.
16. Christensen GJ. Overcoming the challenges of Class II resin-based composites. *JADA* 2006;137(7):1021-3.
17. Clinical Research Associates. Self-etch primer (SEP) adhesives update. CRA Newsletter 2003;27(11/12):1-4.