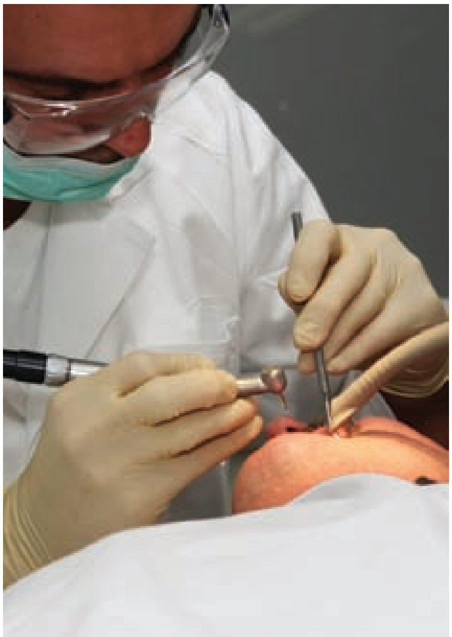

The Expanded Use of Improved Flowable Composite

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Educational objectives

Upon completion of this course, participants should be able to achieve the following:

1. Understand the potential uses for flowable composite materials in restorative dentistry.
2. Understand how mechanical properties of flowable composites affect their clinical performance.
3. Learn the advantages and the technique for using flowable composites as a cavity liner.
4. Understand C-Factor and how to counter the damaging effects of polymerization shrinkage.
5. Learn how to restore certain cavity preparations using flowable composites.

Since the advent of adhesive dentistry, many different composite resin products have found their way into the dental marketplace. Composites consist of inorganic fillers chemically embedded in a resin matrix. The resin matrix has remained almost the same since these materials were first developed in the 1960s, and the continual refinement of these products has been in the realm of the density, size, and character of the filler particles.

A newer type of composite was released in 1996 that has been termed a "flowable composite" because of its low viscosity and ability to be syringed into a cavity preparation with a needle tip. While the heavy-bodied consistency of traditional packable composites is very desirable in gaining the control to shape aesthetic and

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functional restorations, clinicians have found that a material that can flow into cavity preparations has an important role, especially where the deposition of material into a tight space is required.

Most of the flowable composites presently available are not very heavily filled, generally containing from 56 to 70 percent filler by weight. Accordingly, they have reduced mechanical properties such as a higher susceptibility to wear, a higher polymerization shrinkage, and lower flexural strength. Recently a newer product, a superfilled (81 wt. %) flowable composite (Clearfil Majesty Flow) has become available, successfully addressing many of the limitations of the earlier materials and consequently increasing the number of clinical uses for which this class of composite restorative materials is well suited.

While there are many applications for a composite resin that will flow into tight areas such as repairing crown margins or repairing porcelain, this article will focus on maximizing its use as a cavity liner, and as a restorative material for specific cavity preparations.

"Taking into account its viscosity, consistency, handling characteristics and delivery system, a strong flowable composite makes for a suitable choice as a liner on the cut dentin."

Mechanical Properties

When considering restorative materials, the clinician is concerned about several different mechanical properties that will ultimately determine the durability of the restoration. One such property is its flexural modulus, which is the amount of stress required to create deflection of the material. A greater numerical value of the flexural modulus of a material means that the material is stiffer than one with a lower flexural modulus. A cavity liner with a lower flexural modulus means that the product is better able to absorb the contraction forces from the polymerization shrinkage of the overlying composite. Materials with a low value however, often have reduced filler loading that causes greater mechanical problems and greater polymerization shrinkage. Accordingly, a material with a higher flexural modulus needs to be balanced with a high bond strength in order to avoid a failure at the resin-tooth interface.

Flowable Composites as Cavity Liners

Cavity liners such as calcium hydroxide have been historically used to protect the pulp by promoting the deposition of reparative dentin and by neutralizing acids.[1] Unfortunately, this material's high solubility and low compressive strength caused long-term failures. Today however, liners are used to decrease sensitivity, to counter polymerization shrinkage of the overlying composite, to improve adaptation, and to impart better wetability of the cut dentin surface.

Flowable composite resin materials can be useful not only as a liner, but to build up cavity preps, to block out small undercuts and to use as an indirect or direct pulp cap. Other useful materials for liners can be resin-modified glass ionomer cements, which are self adhesive and have a lower flexural modulus than flowable composites, but unfortunately also have lower bond strength to dentin. So, while the flowable composites require a higher bond strength to counter the 15-17 MPa contraction force[2] coming from the polymerization shrinkage, this requirement is routinely achieved with the appropriate bonding agents.

Taking into account its viscosity, consistency, handling characteristics and delivery system, a strong flowable composite makes for a suitable choice as a liner on the cut dentin. Its ability to adapt to the prepared tooth structure allows it to create an intimate union with microstructural defects of cavity preparation prior to placing the restorative composite.[3]

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Polymerization Shrinkage

Polymerization shrinkage is an intrinsic property of the resin matrix. Upon light curing, the single resin molecules move toward each other and are linked by chemical bonds to form a polymer network, a reaction that leads to a significant volume contraction. The main value of high bond strength is the conservation of the marginal seal during polymerization.[4] The stresses that develop as the composite contracts can be transferred to the bonded margins of the preparation creating two potential causes for post-operative sensitivity: gap formation and cusp deformation.[5] In the oral environment, bond failure can result in microleakage, one of the main causes for failure of the restorations. With most flowable composite resin products having a polymerization shrinkage of between 2 and 3.5 percent, this is a significant factor that must be considered as restorations are placed.

Gap formation occurs when the contraction force is stronger than the bond strength of the resin to the tooth surface. The gap creates a nidus for bacterial colonization and recurrent caries with its subsequent irritating action on the dental pulp.[6] Cusp deflection occurs when the contraction force of the curing composite causes the tooth to bend, creating internal stress or implosion fractures.

"C-Factor"

The "Cusp Deflection Factor" or "C-Factor" is defined as the ratio of the number of bonded surfaces to unbonded surfaces. For example, the highest C-Factors occur in Class I and Class V preparations because in each case there are five bonded surfaces and only one unbonded surface (5:1). On the other hand, a liner that is placed only on the pulpal floor has a C-factor of 1, thus reducing the C-Factor of the entire restoration. The lower the C-Factor, the less the chances of gap formation or cusp deflection because the composite is not pulling against as many preparation walls during polymerization. Further composite layering needs to be done incrementally and placed at angles so that the surface to be bonded does not simultaneously contact more than two sides of the preparation. So when doing a Class V restoration, as an example, the operator must avoid placing increments that contact the incisal and gingival walls simultaneously. Class I restorations similarly need to be planned so that opposite walls are not cured together. Lastly, the clinician should avoid the ultrafast curing lights, since the first few seconds account for the majority of the shrinkage that occurs. Slower curing (pulse curing) allows the contraction force that is generated to be taken up by the still unset composite, thus providing a stress reliever and avoiding bond failure. This application method for composites greatly reduces the internal stress that develops within a preparation from cavity preparations with high C-Factors, one of the main causes of post-operative sensitivity.[7] Further, adding composites in increments enables the clinician to create the proper contours with a minimum of finishing.

Fig. 1

Fig. 2

Class I Restorations

Flowable composite resin materials are ideal to restore what have been termed, "Preventative Resin Restorations" (PRRs) because these are the most minimal of the Class I types and the needle tip placement into these small preps assures a well-adapted restoration. Nonetheless, angled incremental deposition is important in order to minimize the contraction force from the setting composite.

In this example of a minimal Class I lesion, (Fig. 1) following satisfactory local anesthesia, the tooth was isolated, then caries removal was accomplished with a 330 bur (Trihawk) and a small flat ended diamond (Brasseler, 6845 012). Following detection of remaining caries (Caries Detector, Kuraray) and its removal with a #2

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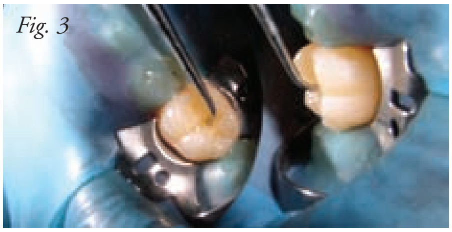
Fig. 3

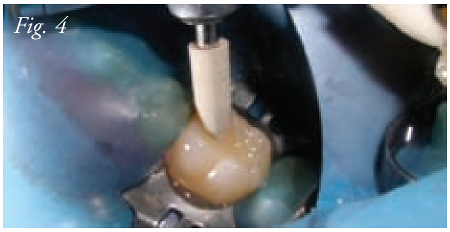
Fig. 4


Fig. 5


Fig. 6


Fig. 7


Fig. 8


Fig. 9

round bur (Fig. 2, see p. 58) the preparation was cleaned with a slurry of coarse pumice and water to remove foreign matter and to create an optimal bonding surface. Next, the bonding material (Clearfil Protect Bond, Kuraray) was applied, beginning with a 20-second application of the antibacterial self-etching primer, followed by air drying and the application of the corresponding bonding resin. The preparation was lightly air dried, then light cured for 20 seconds with the standard halogen curing light. Next, a small amount of superfilled flowable composite resin (Clearfil Majesty Flow, Kuraray) was deposited into the prep, then dispersed using a ball burnisher instrument onto the pulpal floor (Fig. 3), and then light cured. A second thin layer of flowable composite was similarly applied to the walls of the prep and light cured. Lastly, the remainder of the preparation was filled with the flowable composite material and light cured. The minimal finishing and polishing (Figs. 4 & 5) was accomplished with white midget points (Dedeco) coarse pumice (Moyco) and smooth polishing compound (Bon-Ami).

Class II Restorations

The superfilled flowable composite is an excellent material to use in the proximal boxes in Class II preps because of its strength as well as its superior adaptation to the matrix and to the confines of the preparation. When used as the initial increment in the proximal boxes, some researchers have reported reduced microleakage at the enamel margins.[8]

Here, the restoration of the proximal surface and contact was accomplished with the use of a sectional matrix assembly (Composi-Tight, Garrison Dental Solutions) that creates the accurate shape and contact for this aspect of the restoration. The radiographically evident caries in this case did not involve the occlusal surface (Fig. 6), thus allowing for a preparation that involved only the proximal, not the greater occlusal surface.

Following the usual procedure of caries removal, verified by staining (Caries Detector Solution Kuraray) the preparation was limited only to the proximal. Next, application of the bonding agent (Clearfil Protect Bond, Kuraray) proceeded in a the same manner as previously described, the sectional matrix inserted using the angled band forceps, then wedged into place with a “Wanded Wedge” that was included in the kit. Last, a standard length “G-ring” was applied over the matrix to stabilize the entire assembly and create a tight seal, ideal for retaining the flowable composite. Next, the superfilled flowable composite (Clearfil Majesty Flow) was applied as a thin liner over the pulpal wall and gingival floor then light cured (Fig. 7). Then, the proximal box was filled about halfway and a thin layer of the composite was applied to the preparation walls with the flowable composite resin, then light cured again. Finally, a packable restorative composite material (Clearfil Majesty Esthetic) was used to complete the occlusal portion of the restoration. The conservative preparation design greatly simplified any occlusal adjustment, and the sectional matrix, having created a tight seal for the restorative materials, resulted in having to do only minimal finishing (White Midget Points, Fig. 8) and polishing (Bon Ami compound, Bon Ami Company) to complete the restoration (Fig. 9).

Liner Under a Routine Core Buildup

Core buildups have become routine in restorative clinical practice, and often, a heavy bodied light-cured core material is used because of its ease and speed of placement. The flowable composite liner improves the quality of the restoration by its improved adaptation to the cut dentin surface, minimizing the effects of the polymerization shrinkage of the light cured core buildup material.

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Fig. 10

Fig. 11

Fig. 12

Fig. 13

Fig. 14

Fig. 15

Fig. 16

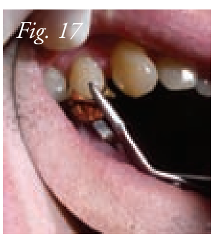

Fig. 17

Fig. 18

This patient came with a heavily filled lower molar with a submarginal mesio-lingual fracture (Fig. 10). Prior to crown preparation and periodontal crown lengthening surgery, a composite core buildup was planned. Following routine caries removal, a Tofflemyre band was fitted around the badly broken down tooth, then the routine application and light curing of the bonding agent (Clearfil Protect Bond) followed by a thin liner (Fig. 11) of superfilled flowable composite resin (Clearfil Majesty Flow). Once this liner was light cured with the standard curing light for 20 seconds, the core buildup material (Clearfil Photo Core) was placed into the preparation in 2mm increments and light cured (Fig. 12). Since the crown and surgery procedures were scheduled for another visit, the core buildup was carved into occlusion for proper function. The tight contact that occurred was opened with a hand instrument (Laschal Surgical Company) that held a segment of ribbon saw (Fig. 13).

Use as a Core Buildup to Treat a Vertical Fracture

In this case, the flowable composite was used entirely as the core buildup; the heavy filler content gave it the strength that was necessary to hold fractured tooth fragments together. This 51-year-old physician came to the office complaining of pain from a fractured tooth #12. Examination revealed a virgin tooth with a mesial-distal fracture resulting in a movable palatal fragment of the tooth. Following satisfactory local anesthetic, a conservative MOD preparation was completed in order to extend the prep as far toward the base of the fracture as possible while avoiding a pulpal exposure (Fig. 14). A standard Tofflemyre matrix was used in this case, since the contacts were going to be opened in a subsequent preparation for a casting. The bonding procedure was accomplished in the usual manner (Clearfil Protect Bond) followed by the liner application (Fig. 15) of flowable composite resin (Clearfil Majesty Flow) that was light cured for 20 seconds. The flowable was similarly dispensed onto the walls of the prep, light cured, then the preparation filled in 1-2mm increments.

Next the tooth was prepared for a bonded partial coverage gold casting so to conserve the maximum tooth structure while supporting the cusps of the tooth (Fig. 16). The bonded preparation design had no proximal boxes or central isthmus and, owing to a low lip line, had a minimal display of gold. Following the impression and provisionalization using methylmethacrylate (Jet Acrylic) cemented with polycarboxylate cement (Durelon) the patient was dismissed until the insertion appointment.

At the following appointment, the provisional was removed, the substrate cleaned with an ultrasonic scaler followed by pumice, then the casting tried in and the occlusion adjusted. The gold ¾ crown was grasped using a crown holder (Laschal Surgical Supply) that allowed the assistant to perform all of the casting preparations including cleaning and rinsing without risk of dropping (Fig. 17). The internal surface of the ¾ crown was etched (K-etchant gel Kuraray) rinsed and dried, then a metal bond enhancer (Alloy Primer Kuraray) was applied and dried. The casting was bonded in with Esthetic Cement (Kuraray) followed by a five-second wave cure. The excess cement was removed using scalers and floss, the occlusion verified, then the patient dismissed (Fig. 18).

Class V Restorations

Similar to Class I restorations, cervical restorations have five bonded surfaces and one unbonded surface, giving them a high C-Factor with the concurrent risk of gap formation and cusp deflection upon light curing. With this in mind, incre-

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Fig. 19


Fig. 20


Fig. 21


Fig. 22

mental filling of the cavity prep began with a thin liner on the pulpal wall (Fig. 19), then the careful deposition of flowable composite onto the gingival wall (Fig. 20). Next, additional increments (Fig. 21) were added, light cured, then the entire restoration contoured and polished (Fig. 22).

Summary

Polymerization shrinkage affects all composite resins, especially the flowables, and occurs as a result of the movement of the resin molecules toward one another during light curing. Manufacturers try to minimize the shrinkage by increasing the filler content of the material without compromising its handling. Clinicians can minimize the effects of the contraction by the use of the first layer as a thin liner, carefully trying to avoid contacting opposite bonding surfaces. Clinicians can also apply subsequent layers of minimal thickness in a similar way, and by utilizing a standard cure lamp as opposed to one that does a rapid cure.

In this article, the author demonstrated three uses for a superfilled composite, utilizing all three means of controlling the potentially harmful effects of polymerization shrinkage helping to insure good long term successful outcomes. ■

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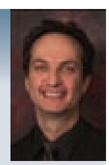
Author's Bio



Dr. Randall G. Cohen is in private practice of general, cosmetic and restorative dentistry in Bucks County, Pennsylvania, since his graduation from Temple University School of Dentistry in 1982. He has published papers in several journals and has lectured nationally on adhesive dentistry.

Disclosure: Dr. Cohen declares having received an honorarium from Kuraray America, Inc., for this course.

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1. The following is not an effective use for a light-cured flowable composite resin restorative material:
   a. Cavity liner
   b. Preventative resin restorations
   c. Cementation of cast gold crowns
   d. Small Class V lesions

2. A higher flexural modulus…
   a. means that a material is less able to bend than one with a lower flexural modulus.
   b. is descriptive of composites as opposed to RMGI's.
   c. material needs to be balanced with a high bond strength.
   d. All of the above.

3. The contraction stress that develops during polymerization of flowable composite resins…
   a. is greater in composites that have a higher filler load.
   b. may be transferred to the bonded margins of the preparation.
   c. generates forces of about 20-25 MPa.
   d. is not relevant in cavity designs with a high C-Factor.

4. Which of these cavity preparations has a C-Factor of 5?
   a. Class IV
   b. Class V
   c. Class II
   d. Class III

5. The composite resin cavity preparation that has the greatest potential for developing post operative sensitivity owing to polymerization shrinkage is
   a. Class I
   b. Class II
   c. Class IV
   d. PRR

6. The lowest C-Factor among the below restorations is:
   a. Liner on the pulpal floor of a Class I
   b. Large Class V
   c. Small Class II
   d. Large Class III

7. The amount of stress required to cause deflection of a composite is expressed as its:
   a. Polymerization shrinkage
   b. Viscosity
   c. Contraction force
   d. Flexural Modulus

8. The reasons to include a flowable composite material in routine restorative dentistry include:
   a. Adaptation to the substrate
   b. Countering polymerization shrinkage of a bulk of overlying composite
   c. Reducing the overall C-Factor of a restoration by using as a liner
   d. All of the above

9. The clinician can take maximum advantage of the bond strength afforded by a light cured bonding agent by using it in conjunction with a liner of which material:
   a. Resin modified glass ionomer cement
   b. Flowable composite resin
   c. Polycarboxylate cement
   d. Calcium hydroxide

10. Pulse curing of composite resin
    a. is best accomplished with a fast-cure light.
    b. dissipates some of the contraction force by the flow of the material.
    c. has no effect on maintaining the integrity of the tooth-resin interface.
    d. increases the polymerization shrinkage and therefore should be avoided.

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