Abstract
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Learning Objectives:
The overall goal of this article is to provide dental professionals with information on the options available for posterior esthetic restorations. Upon completion of this course, the participant will be able to do the following:
1. List and describe the considerations involved in the selection of posterior restorative materials
2. List and describe the history and safety profile of amalgam, its advantages and disadvantages
3. List and describe how polymerization stress occurs and its relevance to restoration failure
4. List and describe the technologies that can now be incorporated into posterior composite restoratives to combat polymerization shrinkage and/or polymerization stress

Author Profiles
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The posterior restorative material of choice depends on the individual clinical situation and patient. Amalgam has a long history of use and clinical success. Esthetic restorations are increasingly in demand, and include glass ionomers, composites and composite resins. Fluoride release is a desirable attribute in a restorative material, as are wear resistance, low polymerization shrinkage and low polymerization stress. Recently, technologies have been incorporated into composite resins that lower polymerization shrinkage and stress.

Introduction
Material selection for restoring posterior teeth depends upon the patient’s age, caries risk, esthetic requirements, ability to isolate the tooth and functional demands placed on the restoration. Although amalgam has been an effective restorative material for Class I and II cavity preparations, patient expectations are varied and range from high functional requirements to high esthetic demands. Each material used to restore posterior teeth has specific advantages and disadvantages and these should be carefully weighed before selecting a restorative material. Composites, glass ionomers and composite resins bond to tooth structure and may reinforce weakened tooth structure. They have proven longevity in minimally invasive preparations, are excellent thermal insulators, esthetic, and produce varying levels of fluoride release, which may inhibit recurrent caries. However, esthetic restorative materials have disadvantages. Composite resin, while the most durable of the esthetic direct restorative materials, has clinical limitations that restrict its use as a posterior restorative material, especially in areas where isolation is poor and wear is high. Resin restorations require greater attention to detail during adhesive placement, increased placement time and are technically more difficult than a similar-sized amalgam restoration. Postoperatively, sensitivity to cold is a frequent complaint with Class II restorations, due primarily to polymerization shrinkage or poor adhesive placement – both of which create leakage at the resin/tooth interface.

Posterior Amalgam Restorations
Amalgam has a long-term clinical history of success for several reasons: the margins corrode and seal, it has good moisture tolerance and excellent wear resistance. Although amalgam does not bond to tooth structure and has other limitations, such as galvanism, high thermal conductivity, and poor esthetics, it may be placed in areas where some contamination, especially blood and saliva, are likely and still provide good clinical results. Amalgam can be used to successfully restore decimated teeth (Figures 1, 2).

Figure 1. Placement of amalgam restorations
Figure 2. Polished amalgam restorations

Amalgam restorations may be bonded to tooth structure with adhesives using the bonded amalgam technique. One of the most clinically successful systems is the 4-META-based Amalgambond Plus (Parkell). In amalgam bonding, the bonding agent bonds to dentin by creating a hybrid layer. The attachment of the bonding resin to amalgam, however, is largely mechanical rather than chemical. Unset amalgam is condensed into the bonding resin before it polymerizes, incorporating fingers of resin into the amalgam at the interface. Belcher and Stewart compared the clinical success of amalgams that were pin-retained, retained with Amalgambond Plus with no filler powder or retained with Amalgambond Plus with filler. At two years, all restorations were intact with minimal sensitivity, good marginal adaptation and no recurrent caries. Summitt et al. recorded a six-year recall of Amalgambond-retained cuspal coverage Tytin restorations with no failures in the bonded amalgam group.
Amalgam has been strongly criticized, especially when used as a restorative material in children, since it contains mercury. Two recent well-conducted randomized controlled clinical studies sponsored by the NIH have provided additional evidence for the safety of amalgam in children. More than 500 children were studied in two clinical trials. In the first clinical trial the children were followed for seven years, and in the second for five years. In each study, children with carious lesions were randomized to one of two groups to receive either amalgam or composite resin restorations. After conducting numerous tests (IQ, blood, urine, social interaction tests, etc.), no significant differences in the health of the children were reported. Nonetheless, amalgam use has declined as greater numbers of clinicians and patients have selected esthetic, adhesive, mercury-free restorative materials.

Fluoride-releasing Materials
Fluoride-releasing materials may be classified into several categories based on similarities in properties (Table 1). Fluoride-releasing composites release low levels of fluoride and have limited ability to recharge; therefore they may not be effective for high caries risk patients. Fluoride-releasing composite resins have better wear resistance and toughness than any other fluoride-releasing material. Glass ionomer and resin modified glass ionomer restorative materials have the highest levels of fluoride release and good recharge, which increases long-term fluoride release. These are useful for the high caries risk patient, but their poor wear resistance and low fracture toughness limits their usefulness as a posterior restorative. However, glass ionomers are useful as a liner or extended base and should be used in deep cavity preparations, especially when the proximal margin is subgingival (sandwich technique) (Figure 3).

A conditioner or primer is provided with glass ionomer restorative materials. These conditioners are weak inorganic acids and clean rather than etch the tooth surface prior to bonding. They effectively improve the bond of the glass ionomer to the tooth structure. While paste/paste resin modified glass ionomers are easier to mix and place than powder/liquid resin modified glass ionomers, paste systems have slightly lower mechanical properties and lower bonds than the original powder/liquid systems. Recently, nanofillers have been added to a resin modified glass ionomer (RMGI) (Ketac Nano, 3M ESPE, St. Paul, Minnesota) to reduce the filler particle size, producing a smoother, more esthetic restoration. All glass ionomers should be bonded to moist tooth structure, after the conditioner is applied and rinsed off or light-cured, depending upon the brand used, and the mixed resin modified glass ionomer applied to the moist tooth and light-cured. After curing, the resin modified glass ionomer is wet-finished.

Although wear with resin modified and high-viscosity glass ionomers has improved, they have significantly more wear than composite resin and should not be used to restore occlusal surfaces in the permanent dentition. Compomers are blends of resin composite and glass ionomer, containing more resin than resin modified glass ionomers but with good fluoride release and recharge. Compomers have mechanical properties closely related to fluoride-releasing resin composites and have been used successfully in the primary dentition. Since single paste compomers require a bonding system to achieve a clinically usable bond and fluoride uptake into cut dentin is blocked by the adhesive, the fluoride release from these materials influences the outer tooth surface only. Compomers are useful, since their fluoride release and wear resistance is midway between that of resin composites and glass ionomers, and they may be a successful esthetic restorative material for children.

Composite Resin
Composite resin use has increased as composite and bonding agents have improved. The first clinical trials measuring the effectiveness of composite resin as posterior restorations reported that composites had poor wear resistance and recommended that their use be restricted to bicuspids, where esthetics was critical. As composite resins evolved, wear resistance improved dramatically, and currently more than 50% of all direct posterior restorations are composite. While physical and mechanical properties have improved, composite resin placement is difficult compared to amalgam.

Table 1: Fluoride-releasing materials – property comparisons

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Fluoride Release</th>
<th>Bond Strength</th>
<th>Strength</th>
<th>Wear Resistance</th>
<th>Fluoride Recharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass ionomers</td>
<td>Ketac-Fil, Fuji II</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>High-viscosity glass ionomers</td>
<td>Ketac Molar, Fuji IX</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Resin-modified glass ionomers</td>
<td>Photac-Fil, Vitremer, Ketac Nano, Fuji II LC, Fuji Fill LC</td>
<td>Highest</td>
<td>Medium</td>
<td>Low – Medium</td>
<td>Highest</td>
</tr>
<tr>
<td>Compomers</td>
<td>Dyract, F-2000, Compoglass</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Fluoride-releasing composites</td>
<td>Heliomolar, SureFil</td>
<td>Lowest</td>
<td>High</td>
<td>Highest</td>
<td>Lowest</td>
</tr>
</tbody>
</table>
Ideal proximal contacts are difficult to obtain with composite resins because composite condensation does not deform the matrix band against the adjacent tooth. To remove some of the difficulties associated with developing a contact area, sectional matrices have been developed.

Composite resin shrinkage during polymerization contributes to marginal breakdown and postoperative thermal sensitivity. Visible light-cured composite resin is placed in 2 mm increments into a cavity preparation, contoured to the desired shape and light-cured. This time-consuming incremental placement procedure is necessary, as light attenuates as it passes through composite resin. Photoinitiators in the composite resin, typically camphorquinone, are activated by visible light in the presence of an amine accelerator/catalyst. The photoactivated diketone/amine complex initiates polymerization of the dimethacrylate resin monomers. Composite resins may contain a combination of photoinitiators, each requiring its own specific wavelength for maximum reactivity. While many composite resins contain camphorquinone, it imparts a yellow color to composites and alternate photoinitiators are used to reduce yellowing. These alternate photoinitiators absorb light in the 390–410 nm range, which is lower than the wavelength emitted by most LED curing lights. Curing composite resin containing these alternative photoinitiators requires the use of curing lights with a wider spectral distribution (such as quartz-tungsten-halogen or plasma arc curing lights that will polymerize all photoinitiators). Poorly cured composite resin has poor mechanical properties and low wear resistance; therefore, most composite resins should be cured in 2 mm increments with a curing light that emits the proper wavelength of light.

Soft-start curing lights and other curing modes have been advocated as a means for decreasing polymerization stress in composite resin restorations. In the last 15 years, various light-curing units have been developed to decrease contraction stress by slowing the rate of composite resin polymerization. These units cure at an initial low intensity and/or a short pulse cure. It is thought that this slower set permits movement of the polymer chains, thereby allowing stress relief and enabling improved marginal integrity. The objective with curing lights with variable output (soft-start polymerization curing units) is to reduce or delay polymerization stress without reducing the conversion rates of the polymer. These methods of “soft curing” include step-curing, ramp-curing and pulse-delayed curing. In vitro studies have shown mixed results. In our laboratory, we could find no significant difference in leakage when using these techniques. The pulse delay or the pulse cure technique places increments of composite resin and cures each increment using 20- to 30-second cure times. The final enamel replacement increment is cured with a brief burst of energy for two to three seconds. After a three-to-five-minute delay to allow the composite time to flow and shrink,
the restoration is finished and polished. After finishing, the restoration is cured at high intensity to complete polymerization of the composite. While this technique has in vitro support, its clinical support is weak, with several studies reporting no significant difference in marginal integrity or marginal discoloration when composite resins are polymerized with or without a soft-start polymerization or with a chemical-cured composite resin.29,30,31,32,33,34 The literature shows that attempts to reduce polymerization stress with a curing light remain unproven.

Flowable Composites
Flowable composite resins are often used today to reduce polymerization stress. Flowable composites are conventional or microfilled composite resins with a reduced filler load, which lowers their viscosity, resulting in better adaptation to the cavity walls.35 Low filler content has caused some concern, since highly filled composites have greater wear resistance for contact-supporting posterior restorations and less polymerization shrinkage than flowable composites.36 However, flowable composite resins are now available with filler loads ranging from 34% to 68%, which provides a wide range of properties. In small noncontact restorations where longevi-

Composite Resin Shrinkage and Stress
Another method to reduce polymerization shrinkage of composite resin uses new chemistry. Polymerization shrinkage of composite resins ranges from 3.7% to 0.9%.41,42 While increasing filler content of composite reduces shrinkage, it also increases composite stiffness, which also increases the forces of contraction.43 Recently, new resin monomers have been developed with different chemistries to reduce polymerization shrinkage stress. The first low-shrinkage commercially available composite resin was Filtek LS (3M ESPE, St. Paul, Minnesota), based on a silorane ring-opening chemistry. In our laboratory, shrinkage measurements for this composite ranged from 0.7% to 0.9% vol. Another newly developed composite, N’Durance (Septodont, New Castle, Delaware), uses dimer chemistry and has shrinkage measurements of 1.2% vol. Thiolene polymers also offer potential for reducing polymerization stress. Carosci and Lu reported that thiolene/thiol-epoxy hybrid networks produced significantly reduced shrinkage stress of 0.2 MPa, which is 90% lower than the stress developed in a control dimethacrylate resin.44,45 This chemistry is not available commercially.

While clinical verification for these low-shrinkage composite resins is still being gathered, it seems likely that these commercially available low shrinkage composites have significant advantages when compared to conventional composite resins.

The shape of the preparation or the C-factor (the ratio of the bonded surfaces of the restoration to the unbonded surfaces) affects the stress created at the margins.46,47 In this classification system, a Class I or Class V preparation would lead to stress reduction” and that the risk of debonding at the adhesive interface due to polymerization contraction is similar for some flowables and highly filled composite resins. In another study supporting this premise, Stavridakis et al. measured the linear polymerization displacement and polymerization forces induced by polymerization shrinkage of 22 flowable resin-based restorative materials.39 Polymerization forces (3.23 to 7.48 kilograms) were recorded showing that flowable resins produced considerable shrinkage stress. Flowable composites vary substantially in contraction force generated as well as wear and other properties. The in vitro and in vivo data demonstrate that using flowable composites to reduce polymerization shrinkage stress is controversial and may be dependent upon the specific flowable material used. This debate is further complicated by the clinical studies demonstrating no difference in marginal integrity between flowable lined composite resin restorations and composite restorations where no flowable was used.40 The consensus seems to be that the major benefit in using a flowable composite is cavity adaptation.
composite resin can partially compensate for shrinkage by flow of the composite material; however, this is time consuming and voids can be created during placement of incremental layers.48 Composite with higher shrinkage produces postoperative sensitivity by creating marginal defects into which percolation can occur49,50 and it is indicated for use as a bulk-fill base to be overlaid with a methacrylate-based composite resin.

Low-stress Composite
A low-stress “adaptable” material has been developed that can be polymerized in one 4 mm increment rather than in the typical 1–2 mm (Figure 3). This material (Stress Decreasing Resin (SDR™) Technology) was engineered to create a new resin system that would allow internal reduction of the stress resulting from polymerization shrinkage. To control stress development within a radically polymerizable material, it was necessary to regulate the overall modulus development while maintaining its polymerization rate and conversion. With SDR™ Technology, a polymerization modulator was chemically embedded in the polymerizable resin backbone (Figure 4). Based on scientific evidence gathered to date, the polymerization modulator synergistically interacts with the camphorquinone photoinitiator to slow modulus development, allowing stress reduction without a reduction in the polymerization rate or conversion. The SDR™ Technology resin provides significantly lower curing stress than other conventional resin systems, while maintaining a high degree of conversion of the material. This ensures the development of the required physical and mechanical properties for the use of the material as a posterior bulk fill flowable base. Essentially, the entire radical photopolymerization process is mediated by the polymerization modulator specially built into the resin; this allows more linear/branching chain propagation without much cross-linking and hence slower modulus development. This modulating effect allows extended polymerization without a sudden increase in cross-link density. Thus, the extended “curing phase” maximizes the overall degree of conversion and minimizes the resulting polymerization stress.

This adaptable material is placed in the box and bulk light-cured up to the enamel margin. Its rheology makes it highly adaptable to the preparation form to avoid the incorporation of voids (Figure 5).

Figure 5. Photomicrograph of bulk-cured stress-reducing resin

Note: excellent adaptation and virtual absence of voids

High translucency allows significant light transmission to bulk polymerize the material. This adaptable composite should not be placed onto the enamel occlusal margin of the cavity preparation due to its low wear resistance. Although not a low-shrinkage material (polymerization shrinkage is 3.6% vol.), it is a low-stress-producing material. It is important to understand that shrinkage stress, not shrinkage, is the cause of many stress related restorative complications. Note in Figure 6 that the shrinkage of the adaptable material is not dissimilar to other commonly used flowable composites, while shrinkage stress is considerably lower (Figure 7). Because the adaptable material is a flowable composite and not indicated for larger occlusal surfaces, a highly filled material should be placed in the final occlusal increment. The material self-levels, ensuring that the occlusal surface of the material is even for placement of the final increment of highly filled material. This two-increment technique reduces placement time and is effective and efficient for Class I and II restorations. In an ongoing clinical trial with the material, we have placed more than 100 restorations with excellent success. The case example below shows the use of SureFil SDR for posterior restorations.

Figure 4. Curing of stress-decreasing resin

Conventional:

SDR
Figure 6. Percent shrinkage of bulk-fill base material compared with other flowable composites

<table>
<thead>
<tr>
<th>Material</th>
<th>SureFil SDR flow</th>
<th>Esthet-X flow</th>
<th>TPH3 flow</th>
<th>Brand A</th>
<th>Brand B</th>
<th>Brand C</th>
<th>Brand D</th>
<th>Brand E</th>
<th>Brand F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Shrinkage</td>
<td>3.6</td>
<td>4.5</td>
<td>4.3</td>
<td>4.4</td>
<td>3.9</td>
<td>3.5</td>
<td>4.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 7. Shrinkage stress of bulk-fill base material compared with other flowable composites

<table>
<thead>
<tr>
<th>Material</th>
<th>SureFil SDR flow</th>
<th>Esthet-X flow</th>
<th>TPH3 flow</th>
<th>Brand A</th>
<th>Brand B</th>
<th>Brand C</th>
<th>Brand D</th>
<th>Brand E</th>
<th>Brand F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrinkage Stress</td>
<td>1.4</td>
<td>3.2</td>
<td>2.9</td>
<td>3.2</td>
<td>3.2</td>
<td>3.1</td>
<td>2.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Case Study**

In this case, a carious lesion was detected distally by radiograph in tooth number 13. A rubber dam was placed over the tooth, followed by cavity preparation and placement of a sectional matrix and band.

Figure 8. Tooth #13 pre-operatively

Figure 9. Preparation and placement of sectional matrix and band

Etchant was first applied, the tooth rinsed and dried, and Prime and Bond NT® was then applied to the dried preparation. SureFil SDR flow adaptable was then placed in the preparation using the disposable unit dose.

Figure 10. Application of etchant

Figure 11. Application of bonding agent

Figure 12. Placement of bulk layer flow adaptable composite

Figure 13. Preparation filled to enamel margin with adaptable flowable composite
Following placement of the bulk layer, this was light cured. Subsequently, EsthetX HD was placed occlusally and light cured to provide the final layer of composite, and the restoration finished.

Figure 14. Placement of final composite layer occlusally

Figure 15. Light-curing of final composite layer

Figure 16. Tooth #13 DO after finishing

Summary

While amalgam has a long history of safe use, patients and clinicians increasingly select esthetic tooth-colored posterior restorative materials. Each material has advantages and limitations. New developments in esthetic composite resins have resulted in low polymerization shrinkage and most recently a low-stress-producing esthetic restorative material. Each restorative material has advantages and should be used with the understanding that the material(s) selected depend upon the needs of the individual patient and clinical situation.

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19. Kanca J 3rd, Suh BI. Pulse activation: reducing resin-based
25. Ibid.
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Dr. Burgess is the Assistant Dean for Clinical Research and the Director of The Biomaterials Graduate Program at the University of Alabama in Birmingham. He graduated from Emory University School of Dentistry and completed graduate training at the University of Texas Health Science Center in Houston. He served as military consultant to the Surgeon General in General Dentistry and was Chairman of Dental Research and Dental Materials at Wilford Hall Medical Center. Dr. Burgess is a diplomate of the Federal Services Board in General Dentistry and the American Board of General Dentistry. He is a Fellow of the Academy of Dental Materials and the American College of Dentists, and an elected member of The American Academy of Esthetic Dentistry and The American Restorative Academy. He is a member of the Academy of Operative Dentistry, The American and International Associations for Dental Research, the Alabama Dental Association, and the ADA. Dr. Burgess is the author of over 300 journal articles, textbook chapters and abstracts and has presented more than 800 continuing education programs nationally and internationally. Dr. Burgess is an active investigator on clinical trials evaluating posterior composites, adhesives, fluoride releasing materials, impression materials and class 5 restorations. He maintains a part-time practice in general dentistry.

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Questions

1. Material selection for restoring posterior teeth depends upon _______________.
   a. the patient’s age and caries risk
   b. esthetic and functional requirements
   c. the ability to isolate the tooth
   d. all of the above

2. _______________ bond to tooth structure and may reinforce weakened tooth structure.
   a. Composites
   b. Glass ionomers
   c. Composite resins
   d. all of the above

3. Amalgam restorations may be bonded to tooth structure with adhesives using the _______________.
   a. self-adhesive technique
   b. chelating amalgam technique
   c. bonded amalgam technique
   d. none of the above

4. Recent studies on amalgam by the _______________ have provided additional evidence for the safety of amalgam in children.
   a. ADA
   b. NIH
   c. FDA
   d. all of the above

5. Fluoride-releasing composites _______________.
   a. release low levels of fluoride
   b. have better wear resistance and toughness than other fluoride-releasing restorative materials
   c. may not be effective for high-caries-risk patients
   d. all of the above

6. Glass ionomer and resin-modified glass ionomer restorative materials _______________.
   a. have the highest levels of fluoride release
   b. have good recharge of fluoride which increases long-term fluoride release
   c. are useful for high-caries-risk patients
   d. all of the above

7. The conditioners used with glass ionomer cements _______________ the tooth surface prior to bonding and effectively bond the glass ionomer to the tooth.
   a. clean
   b. etch
   c. desiccate
   d. all of the above

8. Nanofillers added to resin-modified glass ionomer cement _______________.
   a. improve its esthetics
   b. improve its handling
   c. result in a smoother restoration
   d. all of the above

9. Componders are blends of _______________.
   a. acrylic and glass ionomer
   b. acrylic and resin composite
   c. glass ionomer and resin composite
   d. none of the above

10. Componders _______________.
    a. contain more resin than resin-modified glass ionomers
    b. offer good fluoride release and recharge
    c. have been used successfully in the primary dentition
    d. all of the above

11. Currently more than _______________ of all direct posterior restorations are composite.
    a. 20%
    b. 30%
    c. 40%
    d. 50%

12. The use of _______________ matrices removes some of the difficulties associated with composite resin placement.
    a. circular
    b. sectional
    c. segregated
    d. all of the above

13. Composite resin polymerization shrinkage contributes to _______________.
    a. marginal breakdown
    b. high release of fluoride
    c. postoperative thermal sensitivity
d. a and c

14. The placement of visible light-cured composite resin in 2 mm increments is _______________.
    a. time-saving
    b. time-consuming
    c. efficient
    d. b and c

15. Photoinitiators in composite resin are activated by _______________ in the presence of an amine accelerator/catalyst.
    a. visible light
    b. visible light
c. infrared light
d. none of the above

16. Poorly cured composite resin _______________.
    a. has low wear resistance
    b. has poor mechanical properties
    c. can result from the use of curing lights that do not have the correct spectral distribution for the composite being used
d. all of the above

17. Light-curing units have been developed to decrease contraction stress by _______________.
    a. accelerating
    b. slowing
c. maximizing
    d. none of the above

18. Some studies have reported no significant difference in _______________ when composite resins are polymerized with or without a self-start polymerization.
    a. marginal integrity
    b. marginal discoloration
c. speed of polymerization
d. a and b

19. Flowable composites _______________.
    a. are conventional or microfilled composite resins
    b. have lower viscosity than other composites
    c. result in better adaptation to cavity walls
    d. all of the above

20. Flowable composites with higher percentage filler loads reduce the concern for _______________ compared to lower percentage filler loads.
    a. greater wear resistance
    b. greater esthetic appeal
c. polymerization shrinkage
d. a and c

21. Polymerization shrinkage of composite resins ranges from _______________.

22. Flowable composite resin was originally used as _______________ to improve the adaptation of condensable composites to the prepared tooth.
    a. an indirect pulp cap
    b. a direct pulp cap
c. a resin liner
d. an outer layer

23. Cadanero et al. found that most flowable composites _______________.
    a. had shrinkage stress much higher than conventional resin restorative materials
    b. had shrinkage stress much lower than conventional resin restorative materials
    c. had shrinkage stress comparable to conventional resin restorative materials
    d. none of the above

24. _______________ et al. found that flowable resins produced considerable shrinkage stress.
    a. Stavridis
    b. Stavridakis
    c. Stephanopolos
    d. Staks

25. With respect to flowable composites and the results from clinical studies conducted by various investigators on these, _______________.
    a. their use to reduce polymerization shrinkage stress is controversial
    b. shrinkage stress may be product dependent
c. the consensus appears to be that their major benefit is cavity adaptation
d. all of the above

26. Increasing the filler content of composite _______________.
    a. increases composite stiffness
    b. increases the forces of contraction
    c. reduces shrinkage
d. all of the above

27. The use of new chemistries for composites has resulted in _______________ polymerization shrinkage stress.
    a. increased
    b. maintenance of
c. decreased
d. none of the above

28. The use of _______________ in composite resins results in lower polymerization shrinkage.
    a. dimethyldiallylamine
d. silorane ring-opening chemistry
    c. zinc oxide eugenol
d. a or b

29. The use of a new polymerization modulator embedded in the polymerizable resin has resulted in _______________.
    a. reduced curing stress
    b. an extended curing phase, maintaining a high conversion rate
c. no reduction in the polymerization rate
d. all of the above

30. _______________ of material containing polymerization modulator enables the curing of 4 mm increments versus 2 mm increments for conventional composite resins, saving time.
    a. Low translucency
    b. Low opacity
c. High translucency
d. Low transmissibility
Material Selection for Direct Posterior Restoratives

Name: __________________________ Title: __________________________ Specialty: __________________________

Address: __________________________ E-mail: __________________________ Specialty: __________________________

City: __________________________ State: __________________________ ZIP: __________________________ Country: __________________________

Telephone: Home ( ) Office ( ) Lic. Renewal Date: __________________________

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1. Read the entire course.
2. Complete answer sheets in either pen or pencil.
3. Mark only one answer for each question.
4. A score of 70% on this test will earn you 2 CE credits.
5. Complete the Course Evaluation below.
6. Make check payable to PennWell Corp.

For Questions Call 216.398.7822

Educational Objectives
1. List and describe the considerations involved in the selection of posterior restorative materials.
2. List and describe the history and safety profile of amalgam, its advantages and disadvantages.
3. List and describe how polymerization stress occurs and its relevance to restoration failure.
4. List and describe the technologies that can now be incorporated into posterior composite restoratives to combat polymerization shrinkage and/or polymerization stress.

Course Evaluation
1. Were the individual course objectives met?
   - Objective #1: Yes No
   - Objective #2: Yes No
   - Objective #3: Yes No

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. To what extent were the course objectives accomplished overall?
   - Yes
   - No

2. To what extent did the course instructors accomplish the objectives?
   - Yes
   - No

3. Please rate your personal mastery of the course objectives.
   - Yes
   - No

4. How would you rate the objectives and educational methods?
   - Yes
   - No

5. How do you rate the author's grasp of the topic?
   - Yes
   - No

6. Please rate the instructor's effectiveness.
   - Yes
   - No

7. Was the overall administration of the course effective?
   - Yes
   - No

8. Please rate the usefulness and clinical applicability of this course.
   - Yes
   - No

9. Please rate the usefulness of the supplemental webliography.
   - Yes
   - No

10. Do you feel that the references were adequate?
    - Yes
    - No

11. Would you participate in a similar program on a different topic?
    - Yes
    - No

12. If any of the continuing education questions were unclear or ambiguous, please list them.
    ____________________________________________________________

13. Was there any subject matter you found confusing? Please describe.
    ____________________________________________________________

14. How long did it take you to complete this course?
    ____________________________________________________________

15. What additional continuing dental education topics would you like to see?
    ____________________________________________________________

ANSWER SHEET

Material Selection for Direct Posterior Restoratives

Please photocopy answer sheet for additional participants.

INSTRUCTIONS
No encourage participant feedback pertaining to all courses. Please be sure to complete the survey included with the course. Please mail all questionnaires to:headed personal care.

All questions should have only one answer. Grading of this examination is done manually. Participants will receive confirmation of passing by receipt of a verification form. Verification of Participation forms will be mailed within two weeks after taking an examination.

Course Evaluation and Participant Feedback

There is an ADA CERP Recognized Provider. ADA CERP is a service of the American Dental Association to assist dental professionals in identifying quality providers of continuing dental education. ADA CERP does not approve or endorse individual courses or instructors, nor does it imply acceptance of credit hours by boards of dentistry.

Complaining a single continuing education course does not provide enough information to give the participant the feeling that s/he is an expert in the field related to the course topic. It is a combination of many educational courses and clinical experience that allows the participant to develop skills and expertise.

Completing a single continuing education course is also complete to be listed with the course name and expiration date. The formal continuing education program of this course is approved by the AGD for Fellowship/Mastership in writing.

Any participant who is not 100% satisfied with this course can request a full refund by contacting PennWell Corp.

PennWell Corp.
A Division of PennWell Corp.
P.O. Box 116, Chesterland, OH 44026
or fax to: (440) 845-3447

(For IMEDIATE results, go to www.ineedce.com to take tests online.
Answer sheets can be faxed with credit card payment to (440) 845-3447, (216) 398-7922, or (216) 255-6619.

Payment of $49.00 is enclosed.
(Checks and credit cards are accepted.)

If paying by credit card, please complete the following:
- MC
- Visa
- AmEx
- Discover

Acct. Number: __________________________
Exp. Date: __________________________

Charges on your statement will show up as PennWell

AGD Code 253

Customer Service 216.398.7822