The Art and Science of Class II Composite Restorations

Lou Graham, DDS
John W. Strange, BDS
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LEARNING OBJECTIVES

The overall objective of this article is to provide the reader with information on the placement of Class II composite restorations. After reading this article, the reader will be able to:

- Define and describe the categories of materials available for Class II restoration, as well as their relative attributes
- Review the types of adhesive systems available and their suitability for bonding to enamel and dentin
- Describe the process of polymerization for composites, and methods to reduce polymerization shrinkage and stress
- Delineate methods that are used to reduce shrinkage and stress in composite resins
- List and describe the techniques and types of materials that can be used for the placement of Class II composite resin restorations.

ABSTRACT

Class II restorations are needed frequently. Their placement requires consideration of material properties in selecting the technique that will be used for an individual patient. Class II composite restorations are esthetic, functional restorations that require careful technique and material selection for successful clinical outcomes. Consideration is given to the patient; size and depth of the carious lesion; use of matrices that aid attainment of a good anatomical form for the final restoration; and which adhesive system, composite or combination of composites, and technique will be used.

ABOUT THE AUTHORS

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Introduction

G.V. Black’s classification of cavities is based upon the site of the lesion and the relative prevalence of caries that he observed at these sites.¹ (Table 1) Class II cavities are those that form at the proximal surfaces of posterior teeth. These sites provide a protected environment for a biofilm to develop, organize and mature.² If the individual has sufficient risk factors – for example, unfavorable diet, oral hygiene or salivary chemistry – interproximal plaque can become acidogenic and cause demineralization. In many instances, developing carious lesions can be arrested and even reversed if the patient’s caries risk profile is managed appropriately. Poor physical access to proximal surfaces affects the dentist’s ability to diagnose incipient carious lesions, so proximal lesions may not be diagnosed until they have progressed well into dentin. At this point, remineralization of the lesion is usually not possible and infected tooth structure needs to be excavated and restored.

The goals of restorative dentistry are to preserve healthy tooth tissue; remove and restore diseased tissue; and maintain function, esthetics and freedom from pain.³ Limited access to proximal surfaces means the first goal listed is compromised in Class II restorations, because sound enamel and dentin are often removed to gain access to a Class II carious lesion. The requirements for retention of some restorative materials, and adequate bulk for resistance to fracture, means a significant volume of unaffected dentin and enamel may need to be removed to ensure the longevity of a restoration. Composite resin has a significant advantage over metallic restorative materials because it can be bonded to sound enamel and dentin, allowing for more-conservative cavity designs. Combine this with the obvious esthetic advantages and it is not surprising that the use of composite for restoring posterior teeth has increased significantly over the past 30 years.⁴,⁵ However, composite resin is a technically demanding material, and without careful consideration of its characteristics and limitations, early failure is likely.⁶ This article will describe the use of composite resin for restoring Class II cavities, with the aim of maximizing clinical success.

Options for Class II Restorations

Gold

Gold has been used as a dental restorative material for centuries. Fabricated indirectly, the wax pattern for a gold Class II restoration may be formed on a model or directly in the mouth. The typical cavity preparation is relatively nonconservative, because sound tooth usually needs to be removed to provide a path of insertion. The finished restoration is retained by cement, either zinc phosphate or glass ionomer. Dental gold alloys have excellent strength and wear characteristics, and these restorations are especially suited to situations where cusp protection is indicated. Esthetics and cost influence many patients and practitioners to reject gold as an option.

Ceramic

There are numerous ceramic systems available for restoring Class II cavities, utilizing a number of different material systems based upon glass ceramic, aluminum oxide or zirconia.⁷ Conventional impressions and stone models can be used for fabrication, although CAD/CAM techniques are in their third decade of use.⁸ It is critical to use the appropriate cementation medium for the ceramic system being used; some can be retained with luting cement, while others require resin-based adhesive systems. For example, conventional glass ceramic restorations must be resin-bonded to achieve success. Fracture stands out as a leading cause for failure, necessitating replacement.⁹ Compared with the esthetics of metallic restorations, the esthetics of ceramic Class II restorations can be excellent.

Amalgam

For most of the 20th century, dental amalgam was the de facto standard for direct restoration of posterior teeth, and compared with other available materials, amalgam is relatively low cost.¹⁰ Preparation requires mechanical undercuts to provide retention; however, preparation techniques are generally less technically demanding compared to those for indirect restorations. The lack of requirement for bonding makes amalgam more forgiving in situations where isolation is compromised. It can be successfully utilized in a wide range of situations, from the smallest Class V to full occlusal restoration of molars. With the advent of amalgam bonding agents, amalgam restorations may now also be bonded to dentin and enamel, which creates a hybrid layer – a technique that has been shown to lead to successful outcomes.¹¹ The development of more-esthetic alternatives has seen the use of amalgam falling steadily over the past three decades. Controversies such as amalgam-related illness and the environmental impact of amalgam waste have also influenced this material’s decline.¹² Amalgam remains an important material for the delivery of economically viable dental healthcare around the world.¹³

Glass ionomers

Glass ionomer cement (GIC) is formed when aluminosilicate glass powder reacts with an aqueous solution of a polymer of acrylic acid. Setting occurs by an acid-base reaction. The addition of resin, usually HEMA, results in a resin-modified glass ionomer

<table>
<thead>
<tr>
<th>Table 1. G.V. Black’s Classification of Cavities</th>
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<td>Class I</td>
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<td>Class II</td>
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<td>Class III</td>
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<td>Class IV</td>
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<td>Class V</td>
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Composite resins

Early attempts at using Bowen’s bisphenol glycidyl methacrylate (Bis-GMA)-based resins, developed during the 1960s for restoring teeth, were dogged with problems. Low strength, poor wear resistance and high polymerization shrinkage in early composites led to restorations with low durability and the propensity to leak, resulting in pain and recurrent caries. Early products were suitable only for restorations in anterior teeth, due to their physical property limitations. Considerable effort has gone into refining not only the physical properties of these materials but also the quality of their interface with natural tooth tissue. With careful attention to patient selection and technique, they can be used to reliably restore posterior teeth. Most composite resin restorations are placed directly. Due to the material’s ability to bond to tooth structure, preparations can be more conservative than those required for amalgam (which in general require mechanical retention) or for indirect restorations (which require a tapered path of insertion). They can also be fabricated in the laboratory and resin-bonded in a way similar to ceramic restorations.

Longevity studies comparing the survival of composite resin with amalgam restorations have tended to show superior results for amalgam. However, a recent longitudinal review found that with amalgam restorations have tended to show superior results way similar to ceramic restorations.

Classification and physical properties

Composite resins are classified according to the average size and morphology of their filler particles. Particles may range from 5 µm down to 2 nm. Table 2 shows typical ranges of filler sizes.

The physical properties of composite resins determine their clinical application. In general, the higher the filler loading, the greater the hardness and strength; the benefit of this seems to be maximal at a filler volume of around 60%. Due to their small particle size, microfilled composites have excellent polishability; however, the relatively low filler content results in lower strength and means that their use is restricted to small restorations that are not exposed to high stress or wear. Manufacturers have incorporated blends of filler particles to achieve higher compressive strength, modulus of elasticity and hardness to perform under the occlusal loading of posterior teeth while achieving adequate translucency and polishability for use in the esthetic zone. Practically all modern composites are hybrid in this regard. Flowable composite resins are also used, and they flow into the preparation during placement, reduce chairside time, and reduce polymerization shrinkage and stress. These typically have a reduced filler load, making them flow better into the preparation; however, they result in lower wear resistance. Recently, more highly filled flowable composites have been introduced that are comparable with traditional hybrid composites for compressive strength, flexural strength and wear.

<table>
<thead>
<tr>
<th>Type</th>
<th>Occlusal</th>
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<tr>
<td>Hybrid</td>
<td>0.01 µm – 5 µm</td>
</tr>
<tr>
<td>Microhybrid</td>
<td>0.01 µm – 1 µm</td>
</tr>
<tr>
<td>Microfilled</td>
<td>40 nm</td>
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<tr>
<td>Nanohybrid particles</td>
<td>5 nm – 20 nm</td>
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<tr>
<td>Nanofilled individual particles</td>
<td>2 nm – 20 nm</td>
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<tr>
<td>Clusters</td>
<td>0.6 µm – 1.4 µm</td>
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Composite Adhesive Systems

Current adhesive systems fall into one of two main categories: etch-and-rinse (total-etch) or self-etch adhesives. Within the self-etch category, the system may be a one-step or a two-step technique, while etch-and-rinse adhesives may be two-step or three-step systems. The selection of an adhesive agent depends on whether bonding will be to enamel or dentin, the type of dentin, and clinical preference. The success of any restoration depends upon the ability of the practitioner to achieve a complete seal of the cavity from the oral environment. Gaps between the restoration and dentin fill with fluid. Thermal expansion and contraction and occlusal pressure cause movement of fluid in dentin tubules, which can be painful. Microleakage at the cavosurface margin can allow the ingress of bacteria, with the potential for recurrent caries, sensitivity and staining, especially at dentin margins.

Enamel and dentin have significant structural differences. Enamel is >99% inorganic material, in the form of hydroxyapatite crystals in a prismatic arrangement. Dentin has a less homogeneous structure, comprising approximately 70% hydroxyapatite and significant amounts of collagen. It is permeated by tubules containing cellular processes and water. The proportion of inorganic to organic material in dentin is not uniform from the pulp to the enamel-dentin junction; dentin tubules nearer to the pulp are wider, so there is more water and less inorganic material in them compared to more-superficial dentin. Dentin is a vital tissue with the capacity to react to external stimuli, especially when the protective enamel barrier has been breached by caries or wear. The deposition of secondary dentin further changes the overall composition of this tissue. For example, in sclerotic dentin, the tubules are obliterated by deposition of peritubular dentin and may occur as a result of chronic wear. Resin-based dental materials are essentially hydrophobic, so different techniques are needed when attempting to attain adhesion of these materials to enamel and dentin.

Bonding resin to enamel

The near absence of organic material in enamel and its regular microscopic structure lends itself to bonding with hydrophobic resins. Buonocore is credited with the discovery of etching of enamel to obtain micromechanical adhesion of acrylic to enamel. The use of the etch-and-rinse (total-etch) technique involves the application of 37% phosphoric acid to enamel for 20 – 30 seconds, followed by rinsing and thorough drying. Enamel is demineralized, but not uniformly. Electron micrographs of etched enamel typically show preferential loss of hydroxyapatite at either prism cores or boundaries. This surface can be permeated by an unfilled, low-viscosity resin, with formation of resin tags into the etched enamel. Differing concentrations of etchant and etch-rinse procedures appear to have little influence upon penetration of resin and bond strengths. Self-etch adhesives are less successful than etch-and-rinse adhesives systems on unprepared enamel. Composite resin restorative material is applied to the bonding resin and forms a chemical bond to it during polymerization.

Bonding resin to dentin

As with enamel, the nature of the bond to dentin is micromechanical due to interlocking of resin with microscopic irregularities in dentin. The bond is optimal superficially, where there is a relatively large surface area of intertubular dentin. Bond strength becomes compromised with deeper and caries-affected dentin. The adhesive bond to dentin is optimized when the surface of the dentin is slightly moist at the time of bonding.

The traditional approach is a three-stage etch-and-rinse (total-etch) technique. First, prepared dentin is chemically treated with acid to remove debris left by rotary cutting instruments (the smear layer). This also lightly etches intertubular dentin, exposing the ends of collagen fibrils. After rinsing and lightly drying the dentin, the second step is application of a relatively hydrophilic primer in an organic solvent, which can penetrate dentin tubules and intermingle with exposed collagen while being chemically compatible with hydrophobic bonding resins. Primers can be based upon hydroxyethyl methacrylate (HEMA), which, while technically hydrophobic, is able to form a hydrogel in contact with water. Finally, a hydrophobic bis-GMA resin is applied and polymerized, ready for application of restorative material. While effective, the three-stage approach of resin-dentin bonding is perceived to be complex and time-consuming, although some authors still report advantages by keeping the steps of etch, prime and bond separate.

Self-etch adhesives do not require a separate etch-and-rinse step, because the adhesive is self-etching and includes the etchant. Unlike with etch-and-rinse adhesives, the smear layer is combined into the adhesive. For standard Class II restorations, both etch-and-rinse (total-etch) and self-etch adhesives result in successful clinical outcomes.

Glass ionomer cements and self-adhesion

A third method for sealing dentin is to use an intermediate layer of glass ionomer. Where cavity margins are in dentin – for example, at the gingival margin of a deep Class II cavity – the glass ionomer may be present at the margin, forming an “open sandwich.” Unlike resin-based dental adhesives, glass ionomer is self-adhesive and able to chemically bond to both organic and inorganic components of dentin. It can be applied in a thicker layer than can resin-based adhesives, therefore reducing the volume of composite resin required in the cavity and minimizing the effects of polymerization shrinkage. Release of fluoride from glass ionomer also offers protection against recurrent caries in the event of microleakage.

Setting Reaction of Composites: Polymerization

The initiation of polymerization is achieved either chemically
or by exposure to visible light. Chemical initiation occurs when an organic peroxide (the base) reacts with a tertiary amine activator (the catalyst), producing free radicals. These two components are present in the two separate pastes of chemical cure composites and are then mixed. Two-component base-catalyst composites are now rarely used.

The setting of most commercially available composite resins is photo-initiated. The initiator in these products is typically camphorquinone, which, when exposed to light in the blue range of the visible spectrum (400 nm – 500 nm), enters an excited state and can react with a tertiary amine to release free radicals. The organic monomer of an uncured composite resin contains an unsaturated carbon double bond (C=C) at each end. Free radicals released by initiation and activation cleave these bonds, which are then able to react with those of adjacent monomers. The result is a cross-linked polymer, although it should be noted that not all reactive groups end up participating in the final polymer. Even in an optimally cured composite resin, the "degree of conversion" may be 75%. Conversion is affected by:

- The thickness of the layer
- The color of the composite (very dark and very light shades may absorb or reflect light, so longer curing times are required)
- Efficiency of the light source (quartz-halogen light sources should emit at least 400 mW/cm²)
- Time of exposure to light (follow manufacturer’s recommendations)

The oxygen-inhibited layer at the surface of freshly cured composite resin is important for achieving a homogenous restoration when applying the material in increments; unreacted end groups are available for reaction with the next layer when it is applied and the curing process initiated. At the restoration surface, however, oxygen-inhibited composite resin has reduced physical properties and is undesirable. This problem can be reduced by (a) curing the final increment under a matrix, or (b) overbuilding the final increment and then removing the less completely polymerized layer with rotary instruments during finishing. It is important to note that the polymerization of composite resin is inhibited by oxygen and contact with eugenol-based materials. Eugenol is present in some temporary restorative materials and cements, so such products should not be used if a composite resin or other resin-bonded restoration is intended.

Polymerization Shrinkage and Stress

Shrinkage of composite resin during polymerization can amount to 2% – 3% by volume for bis-GMA-based resins and contributes to many of the problems leading to failure – for example, stress and microcracks, adhesive failure, and tooth deformation. The reduction in volume occurs as covalent bonds form and intermolecular distances are reduced. The effects of polymerization shrinkage can be reduced by attention to clinical technique; however, new monomer systems have been introduced that significantly reduce shrinkage. Silorane monomers are a hybrid of silane and oxirane moieties; these have been introduced into one composite resin (Filtek™ LS, 3M ESPE) and polymerize by a ring-opening mechanism. They exhibit polymerization shrinkage in the region of 0.9%. Another innovation has been the introduction of low-stress composite resin (SureFil® SDR® flow, DENTSPLY Caulk) that offers up to a 70% reduction in shrinkage stress compared to that of conventional resins and has improved flow compared to that of traditional posterior composites. The reduced stress in this urethane methacrylate resin may be related to its relatively slow rate of polymerization. This allows for more-thorough curing of the material and reduces polymerization stress. In addition, this material can be cured up to 4 mm in depth. Note, the bonded surface-to-unbonded surface ratio (the C-factor) influences the amount of marginal stress. A low-stress characteristic is particularly important in areas of higher C-factors such as Class I and Class II preparations. Other low-stress materials have also been introduced.

Clinical Procedures

Case selection

As for any dental restoration, to maximize longevity of a Class II composite resin restoration, the ideal patient has excellent home plaque control and visits a dentist and hygienist regularly for diagnostic and preventive services. The site and size of the cavity to be restored may influence the dentist’s choice of restorative material. Larger restorations situated more posteriorly in the mouth are subject to greater forces in occlusion. If the cavity is particularly large, or if the patient shows signs of bruxism or has a history of fracturing teeth or restorations, then more-durable options should be discussed with the patient.

Cavity preparation principles

Composite resin restorations rely on a bond to tooth tissue for an adequate seal; therefore, isolation is an important consideration. The gold standard for preventing saliva contamination is the use of a rubber dam, and this should be applied where possible. Unlike cavity preparations for amalgam restorations, those for composite resin do not require undercuts for retention, enabling the preparation to be more conservative and removing the need for the removal of healthy tooth tissue to create mechanical retention. To prevent stress concentration and minimize the risk of voids during placement, all internal line angles should be rounded. Bevels may increase the surface area for bonding to enamel; however, they are not indicated on occlusal cavosurface margins, because the resulting thin layer of composite resin would be prone to fracture in function. At completion of preparation of the Class II cavity, particular attention should be paid to the amount of enamel remaining at the gingival margin; if this is thin or absent, then consideration should be given to protecting this area from leakage – for example, by using glass ionomer.

The sandwich technique utilizes two different materials in the preparation, reducing chairside time and the need for thin, incre-
mental layers of composite. The two layers of material consist of either a flowable composite or glass ionomer cement followed by placement over this layer of a high-strength, load-bearing composite. The sandwich may be either open or closed. With the closed sandwich technique, the inner layer of flowable composite or glass ionomer is completely covered by the outer layer of composite. In the case of the open sandwich technique, the depth of the box approximatively contains only the flowable composite or the glass ionomer, which is thus exposed at the margins of the box. In the case of glass ionomers, this also offers the advantages of fluoride release at the margins and moisture tolerance, which is an asset in areas where complete isolation is difficult to achieve. The tunnel preparation is another type of Class II preparation design that can be used when minimal dentinal caries is present approximatively and no caries is present occlusally at the isthmus. This design avoids the need to remove enamel and dentin to create a proximal box and isthmus but is also technique-sensitive. The vast majority of Class II preparations are standard-design.

Filling the preparation and light-curing

A number of matrix designs are available for Class II restorations. Traditional matrices were originally developed for amalgam. In recent years alternative designs, including sectional matrices, have been introduced that are ideally suited for adaptation to contact points for good contouring of the final restoration. One of the differences between amalgam and composites can be found in their handling properties – recent posterior composites offer improved handling, also making attainment of an ideal form easier.

Many Class II preparations need to be filled incrementally due to their depth, because the depth of cure for the majority of light-cured composite materials is limited to a maximum of 2 mm. Also, the dentist needs to be aware of the effect of polymerization shrinkage with composites, which can account for a volumetric shrinkage of up to 3%. Using an incremental buildup technique for these composites is necessary for curing and to minimize (a) the formation of gaps, which can lead to pain on pressure, leakage, sensitivity and recurrent caries; and (b) stress in the restoration and surrounding tooth tissue caused by contraction of composite resin against bonded preparation surfaces. While the majority of composites require multiple layering steps with polymerization of increments of up to 2 mm in depth, some recent composites such as SureFil® SDR® flow (DENTSPLY Caulk) offer the ability to fill in increments of up to 4 mm, reducing the number of steps, saving time and reducing the risk of voids.

Marginal adaptability is also a critical point because the greatest incidence of microleakage occurs at the gingival margin. Curing time varies with the depth of the restoration, distance from the light to the area being cured, collimation of the light and overall power of the light. It is important to understand that lights in general lose energy at distances greater than 5 mm. Devices that are collimated lose less light; however, light energy is still lost, so one must light-cure with additional time. In addition, undercuring has been shown to cause many negative outcomes, so it is important to ensure that the composite is light-cured for at least the minimum time and within the increment depth recommended by the manufacturer. Polymerization of light-activated composite resin commences at the surface nearest the light source; as the process proceeds deeper, the net effect is contraction of the material in the direction of the light. As a general principle, the adverse effects of polymerization shrinkage can be reduced by placing each increment in the cavity so it is in contact with as few surfaces as possible, ideally one surface at a time. Then light is applied from a position to control the direction of shrinkage.

After placement, finishing and polishing of composite restorations result in a smooth surface with high luster and gloss. In addition to the obvious esthetic benefits, a smooth surface also results in less plaque accumulation and staining of the final restoration. A further option is the use of a liquid sealant that both seals the surface and imparts a high gloss. Studies have shown that this sealing reduces marginal gaps and microleakage and may improve wear resistance.

Case Studies

Modern adhesive dentistry continues to move in a direction that incorporates new technologies that address the complexities of performing direct adhesive restorations. Such advancements have been quite apparent in the growing trend toward low-stress materials that minimize issues seen with traditional composites. The cases below demonstrate the techniques and results with modern posterior composites in Class II restorations.

Case 1

A 46-year-old patient presented with a Class II lesion on the distal surface of tooth number 5. In this clinical situation, it is key to avoid damaging the adjacent tooth during preparation. It is equally important to prepare the tooth conservatively to maximize remaining tooth structure. In this case, the central groove had a numerical reading of less than 10 using the DIAGNOdent (KaVo Dental) as an adjunctive diagnostic tool, and thus the central fossa would not be incorporated into the final restoration. The area was anesthetized with 1 carpule of 4% Septocaine (1:200,000), and the procedure began with the placement of a small WedgeGuard (Palodent® Plus System, DENTSPLY Caulk) from the buccal aspect in order to prevent any damage to the adjacent surface during preparation. (Figures 1,2)

The initial preparation was performed using a standard-size fissurotomy bur, which has a tapered flare and minimal dimensions, thereby resulting in a very conservative procedure. (Figure 3)

Final caries removal is based on utilizing burs that remove only infected, demineralized dentin. One option is the CeraBur® (Komet), a ceramic bur at speeds of 1,200 – 1,500 rpms and is
available in four sizes. A second option is the single-use Smart-Prep bur (SS White), which is utilized at speeds of approximately 5,000 rpms. This bur has a Barcol hardness that is much lower than that of healthy dentin, thereby sparing healthy dentin during removal of infected, demineralized dentin. Once the caries is removed, the preparation is beveled along all the line angles – including possibly the gingival line angle – to allow better enamel prism bonding. The guard itself is then detached from the wedge, and if any additional beveling is required, it can be performed at this time. The matrix band (Palodent® Plus) is then inserted, taking care to ensure a sealed gingival margin and to ensure that the band aligns with the proximal marginal ridge and encloses the line angles coronally. Using a matrix band with anatomical contouring to approximate the ideal contact zone is preferable. (Figure 4) After the retaining ring is inserted, the band should be burnished, with the matrix band tab folded onto the adjacent marginal ridge, and its stability verified. If the wedge is too coronal, the contact will be too incisal and/or nonexistent. If the band itself is not stable, it is highly recommended to remove the wedge (the retaining ring will stay in place) and insert a larger wedge through the “V” notch. This can often include a wood wedge that is customized by removing some of the wood to allow placement of the ideal contact.

A total-etch adhesive system was selected and the etchant applied to the enamel margins for the initial 10 seconds and then also applied to the dentin in the preparation for 10 seconds. Thus, a total of 20 seconds of etching for the enamel and 10 seconds for the dentin was achieved. (Figure 5) (If a self-etch adhesive is selected instead of a total-etch system, performing a selective etch of the enamel margins for 20 seconds followed by rinsing and high-speed suction air-drying can enhance enamel bond strengths.)

After applying the etchant, it was removed with copious irrigation, and the preparation was dried using high-speed suction. The bonding agent (XP BOND®, DENTSPLY Caulk) was next applied from a unidose capsule for 20 seconds and then air-dried with a light air stream from an air-only syringe for 5 seconds at a distance of approximately 10 cm, followed by a more aggressive air application directly above the restoration for at least 5 more seconds. The bonding agent was then light-
cured for an initial 10 seconds at a power level of 1,750 mws. It was then light-cured for another 10 seconds with a “swivel” technique – instead of simply holding the light in one position, this involves swiveling the light directly over the box both buccolingually and mesiodistally to ensure that all the walls are light-cured. The posterior flowable composite restorative (SureFil® SDR® flow) was then inserted into the Class II box, placing the tip of the cannula on the gingival floor at the corner of a line angle and slowly injecting the composite into the box (with the tip always immersed in the material to minimize the

Figure 5. Total-etch technique: Application of etchant to enamel and dentin

Figure 6. Placement of flowable composite into the base of the preparation

Figure 7. Layer of flowable composite placed

Figure 8. One-step finisher and polisher

Figure 9. Final restoration from occlusal aspect

Figure 10. Contact point from buccal aspect
potential for air bubbles) while taking care to leave 2 mm of coronal space for the final composite layer that would be placed over the flowable composite. (Figure 6) The material was then allowed to “self-level” for approximately 5 seconds, followed by light-curing (again following the above guidelines). (Figure 7) This flowable composite material has been shown to have excellent marginal adaptation to significantly lower the stress occurring immediately after light-curing and can be placed in bulk increments of up to 4 mm, minimizing the number of steps. Using the universal color allows for easy conversion to the material’s final state during polymerization. The final increment in this case was placement of a highly filled, low-flow flowable composite (Beautifil® Flow Plus, Shofu), shade A2, which was light-cured from the occlusal aspect.

The retaining ring and matrix/wedge were removed, and an additional 10 – 20 seconds of light-curing from the buccal and lingual aspects along the distal line angles was completed. Finishing and polishing were performed by contouring and smoothing the line angles, reducing the occlusal area with finishing burs and then using a finisher, using heavier pressure to remove coarse scratches and lighter pressure to remove finer scratches (Figure 8) before using a polisher. The final restoration was polished, esthetic and possessed excellent anatomical form and contact points. (Figures 9, 10)

Case 2

In this case, a 98-year-old patient presented with advanced Class II carious lesions that had not been present on her last series of bitewings, taken 18 months earlier, when she had last attended, and she did not return for dental examinations in the interim. As seen on the X-ray, there were three lesions that were already advanced. (Figure 11)

Given the extent of the caries and depth of the lesions, after preparation each one was initially filled with a flowable composite (SureFil® SDR® flow) in a 4 mm-deep layer and light-cured, and then final composite placement was performed over that. Given the patient’s age, it was decided to perform one restoration at a time, in a 45-minute appointment. At the first visit, tooth number 13 was prepared as previously described. The sectional anatomical matrix/wedge and retaining ring were used
for this case (as in Case 1) to create an ideal Class II contact. (Figure 12) In this case, after etching and bonding and light-curing the layer of flowable composite, a low-stress packable composite (SonicFill, Kerr) was placed using its sonic handpiece, which lowers viscosity of the composite for placement prior to it becoming more packable again for condensing, and then was condensed. Prior to curing, the excess was removed and the outer layer carved and light-cured. After the retaining ring was removed along with the matrix band and wedge, the interproximal areas were again light-cured and the final restoration finished and polished. (Figures 13, 14) The final restoration was densely packed and verified on the radiograph. (Figure 15)

Tooth number 15 was treated at the next appointment, and had a deeper carious lesion making it more complicated. (Figure 16) After careful caries removal to avoid pulpal exposure, a Universal ring was placed over a wood wedge, which was utilized due to the large embrasure. The same sequence as before was then followed, with etching, bonding and placement of flowable composite. With this restoration, the initial bonding agent was placed and light-cured for 30 seconds due to the depth of the restoration. Given that the tooth occluded a removable partial denture, the same flowable composite was also placed in the final 4 mm layer because it was far easier to manipulate and given the patient’s age, wear was not seen as an issue. After light-curing, the matrix band was removed and additional light-curing applied interproximally. The final restoration can be see in figure 17. Another appointment was made to restore number 14 at a future date.

**Case 3**

In this case, treatment involved removal of an amalgam restoration from tooth number 20 and replacement with a composite restoration. Prior to removal of the alloy, the preexisting occlusion was verified and a WedgeGuard was tried in and then removed for rubber dam placement prior to amalgam removal. The amalgam was removed with a traditional carbide bur, and then a ceramic bur was utilized to remove the infected dentin. After this step, bevels were created with various diamond finishing burs to complete the preparation. The WedgeGuard was removed and a new matrix band was inserted along with the narrow retaining ring. A sectional anatomical matrix with a retaining ring was utilized and contoured for proper contact design, and a wooden wedge was used to seal the gingival margin because the largest wedge in the
The restoration of choice in this situation was a two-layered approach using a flowable composite and hybrid composite. The technique again involved a total-etch approach with thorough rinsing and high-speed suction drying. Placement of the bonding agent (Prime & Bond® NT™, DENTSPLY Caulk) for 15 – 20 seconds and the same air-drying technique as stated previously was utilized, followed by 10 seconds of light-curing as close to the restoration as possible and then another 10 seconds incorporating the swivel approach. Flowable composite was placed approximately 3 mm in thickness and allowed to “self-level.” After light-curing, another thin layer of this flowable composite was placed over the pulpal floor and a little over the cured flowable composite. This second layer was not light-cured at this point, and a layer of hybrid composite (TPH3, DENTSPLY Caulk) was placed into the preparation, compressing the flowable composite to optimize a smooth transition from the cured flowable composite to the final overlying layer. After condensing and carving the composite, the excess was removed and light-cured from both the buccal occlusal and lingual occlusal aspects (transenamel curing) for 10 – 20 seconds. (Figure 22) Finishing and polishing were then performed sequentially using interproximal discs, diamond finishing burs and polishers. (Figure 23)

**Conclusions**

The placement of composite restorations in posterior teeth continues to increase and requires consideration of multiple factors. Selecting materials with reduced polymerization shrink-
age and stress, as well as high strength and optimized handling characteristics, is important for clinical success, as is the use of good clinical techniques. Current Class II composite restorative materials offer the clinician the ability to place durable, long-lasting and esthetic composite restorations.

References

1. G.V. Black’s classification of cavities is based upon the __________.
   a. site of the lesion
   b. relative prevalence of caries he observed at these sites
   c. type of material used
   d. a and b

2. Unaffected dentin and enamel may need to be removed for __________.
   a. access
   b. retention of some materials
   c. adequate bulk of a material
   d. all of the above

3. Dental gold alloys __________.
   a. have excellent strength and wear characteristics
   b. are esthetic
   c. are old-fashioned
   d. are relatively inexpensive

4. Amalgam restorations __________.
   a. must always be bonded
   b. are forgiving of the presence of moisture
   c. are an outdated mode of restoration
   d. all of the above

5. Glass ionomer cement __________.
   a. is self-adhesive
   b. sets by an acid-based reaction
   c. is highly suitable for stress-bearing areas
   d. a and b

6. Early composite resins for dental restorations were first developed during the __________.
   a. 1950s
   b. 1960s
   c. 1970s
   d. 1980s

7. For standard Class II restorations, __________ adhesives result in successful clinical outcomes.
   a. etch-and-rinse
   b. self-etch
   c. pure-etch
   d. a and b

8. Composite resins are classified according to the __________.
   a. average size of their filler particles
   b. composition of their filler particles and use
   c. morphology of their filler particles
   d. a and c

9. Composites contain __________.
   a. an inorganic resin monomer, organic fillers and a silane coupling agent
   b. an organic resin monomer, inorganic fillers and a silane coupling agent
   c. an organic resin monomer, inorganic fillers and a silose coupling agent
   d. none of the above

10. Microfilled composites have __________.
    a. excellent polishability
    b. a relatively low filler content
    c. lower strength which restricts their use to small restorations in areas of low stress
    d. all of the above

11. __________ are the two main categories of current adhesive systems.
    a. Etch-and-rinse and total-etch
    b. Etch-and-rinse and selective etch
    c. Total-etch and self-etch
    d. Selective etch and self-etch

12. Etch-and-rinse adhesives may be a __________.
    a. one-step or two-step system
    b. two-step or three-step system
    c. one-step, two-step or three-step system
    d. none of the above

13. Microleakage at the cavosurface margin of restorations can result in __________.
    a. recurrent caries
    b. sensitivity
    c. staining
    d. all of the above

14. The adhesive bond to dentin is optimized when the surface of the dentin is __________ at the time of bonding.
    a. desiccated
    b. very moist
    c. slightly moist
    d. none of the above

15. A recent longitudinal review found that __________.
    a. a higher proportion of composites than amalgams failed over a given period
    b. a higher proportion of amalgams than composites failed over a given period
    c. the failure rate for both amalgams and composites was negligible
    d. a and c
16. Flowable composite resins __________.
   a. typically have a reduced filler load
   b. reduce polymerization shrinkage
   c. reduce chairside time
   d. all of the above

17. Resin-based dental materials are essentially __________.
   a. hydrophilic
   b. hydrophobic
   c. cladophobic
   d. b and c

18. Conversion of photo-initiated composites is __________.
   a. always 100%
   b. affected by the thickness of the material and material itself
   c. affected by the color of the material
   d. b and c

19. The polymerization of composite resin is inhibited by __________.
   a. hydrogen
   b. oxygen
   c. contact with eugenol-based materials
   d. b and c

20. Shrinkage of composite resin during polymerization __________.
    a. contributes to microcracks and adhesive failure
    b. occurs as covalent bonds form and intermolecular distances are reduced
    c. can be reduced by attention to clinical technique
    d. all of the above

21. Polymerization shrinkage can be reduced by __________.
    a. using a composite incorporating a silorane ring
    b. using a low-stress composite
    c. using a flowable composite for the bulk fill first
    d. all of the above

22. For preparations intended for composite restorations __________.
    a. internal line angles should be rounded to prevent stress concentration
    b. bevels may increase the surface area to be bonded
    c. only a little retention is required
    d. a and b

23. A sandwich restoration consists of __________, placed in separate increments.
    a. a layer of glass ionomer cement and then composite resin
    b. two layers of glass ionomer cement
    c. a layer of flowable composite resin and then composite resin
    d. a or c

24. Composite resin restorative materials have a depth of cure that depends on the material and is maximally __________.
    a. 2 mm
    b. 3 mm
    c. 4 mm
    d. 5 mm

25. After placement of a composite restoration, finishing and polishing of the composite restoration results in __________.
    a. a smooth surface
    b. less plaque accumulation
    c. a more esthetic restoration
    d. all of the above

26. Using a standard-size __________ for initial preparation results in a conservative procedure.
    a. round bur
    b. fissurotomy bur
    c. pear-shaped bur
    d. all of the above

27. A ceramic bur utilized at speeds of 1,200 – 1,500 rpms spares healthy dentin while removing infected, demineralized dentin because it __________.
    a. is faster
    b. has a hardness that is much lower than healthy dentin
    c. has a hardness equivalent to enamel
    d. a and b

28. Using a matrix band with anatomical contouring along with a guard __________.
    a. helps with the shape of the contact zone
    b. is preferable
    c. helps protect the adjacent tooth
    d. all of the above

29. If a self-etch adhesive is selected instead of a total-etch system, performing a __________ for __________ can enhance enamel bond strengths.
    a. selective etch of the dentin; 10 seconds
    b. selective etch of the enamel margins; 10 seconds
    c. selective etch of the enamel margins; 20 seconds
    d. selective etch of the enamel margins; 5 seconds

30. Using a flowable composite that can be cured in 4 mm increments __________.
    a. is useful for large preparations
    b. is suitable for Class II restorations
    c. is minimally invasive
    d. a and b
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EDUCATIONAL OBJECTIVES
- Define and describe the categories of materials available for Class II restoration, as well as their relative attributes
- Review the types of adhesive systems available and their suitability for bonding to enamel and dentin
- Describe the process of polymerization for composites, and methods to reduce polymerization shrinkage and stress
- Delinate methods that are used to reduce shrinkage and stress in composite resins
- List and describe the techniques and types of materials that can be used for the placement of Class II composite resin restorations

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1. Clarity of objectives ................................................. 3 2 1
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3. Benefit to your clinical practice ................................. 3 2 1
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7. Clarity of quiz questions ......................................... 3 2 1
8. Relevance of quiz questions .................................... 3 2 1
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10. Did this lesson achieve its educational objectives? ?Yes ?No
11. Are there any other topics you would like to see presented in the future?

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Fill in the circle of the appropriate answer that corresponds to the question on previous pages.

1. A     B     C     D  16. A     B     C     D
2. A     B     C     D  17. A     B     C     D
3. A     B     C     D  18. A     B     C     D
4. A     B     C     D  19. A     B     C     D
5. A     B     C     D  20. A     B     C     D
7. A     B     C     D  22. A     B     C     D
8. A     B     C     D  23. A     B     C     D
10. A     B     C     D  25. A     B     C     D
11. A     B     C     D  26. A     B     C     D
12. A     B     C     D  27. A     B     C     D
15. A     B     C     D  30. A     B     C     D

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