Esthetic Anterior Composite Restorations
A Peer-Reviewed Publication
Written by Jeff T. Blank, DMD

Abstract
When compared to their ancestors, composite restorative materials possess superior physical properties, come in a full range of vital shades and opacities, and polish to a gloss-like luster. Many of these materials are considered universal, suitable for both posterior restorative and esthetic anterior applications. Several factors have contributed to current trends in restorative and cosmetic dentistry. The latest advances in adhesive and restorative materials have led to the ability to use less invasive treatment modalities to yield highly esthetic and durable restorations, and the combination of minimally invasive techniques and modern biomimetic restorative materials has proven to be the state-of-the-art solution for practitioners and patients. Whereas early brands of composite offered only “body” shades based on the Vita shade guide and appeared dull and dense, contemporary materials offer an expanded range of shades and varying opacities designed specifically for layering of direct restorations. Recognizing the distinction in thickness, color and morphology of natural dentin and enamel, it is necessary to replicate these histological tissues in composite restorations. This requires the use of composite formulations that are optically similar to each layer, and sculpting these materials replicates the morphology of each in the area being restored.

Learning Objectives:
The overall goal of this course is to provide the reader with information on the use of single layering and multiple layering composite techniques. On completion of this course, the participant will be able to do the following:
1. Describe the development of composite materials and the general changes that have occurred in their properties over time
2. List and describe the advantages that modern anterior composite materials offer for esthetic restorations
3. Define and discuss the anatomical features of the tooth structure and the physical features and appearance of the various components of tooth structure
4. Describe and discuss the use of the histological layering technique for the creation of anterior composite restorations.

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Dr. Blank maintains a full-time practice, focusing on cosmetic and restorative dentistry. Dr. Blank has lectured extensively at major dental meetings throughout the U.S., as well as overseas in Germany, Sweden and the Pacific Rim on cosmetic materials and techniques. He is an Adjunct Instructor in the Department of General Dentistry, and guest lecturer for graduate and undergraduate studies, at the Medical University of South Carolina, College of Dental Medicine. Dr. Blank graduated from MUSC in 1989, and is an active member of the American Academy of Cosmetic Dentistry, the Pierre Fauchard Honorary Society, the American Dental Association, and the Academy of General Dentistry. In his leisure time, Dr. Blank enjoys traveling, biking, camping and fly-fishing with his family.

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Expiration date: Aug. 2014
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**Abstract**

When compared to their ancestors, composite restorative materials possess superior physical properties, come in a full range of vital shades and opacities, and polish to a gloss-like luster. Many of these materials are considered universal, suitable for both posterior restorative and esthetic anterior applications. Several factors have contributed to current trends in restorative and cosmetic dentistry. The latest advances in adhesive and restorative materials have led to the ability to use less invasive treatment modalities to yield highly esthetic and durable restorations, and the combination of minimally invasive techniques and modern biomimetic restorative materials has proven to be the state-of-the-art solution for practitioners and patients. Whereas early brands of composite offered only “body” shades based on the Vita shade guide and appeared dull and dense, contemporary materials offer an expanded range of shades and varying opacities designed specifically for layering of direct restorations. Recognizing the distinction in thickness, color and morphology of natural dentin and enamel, it is necessary to replicate these histological tissues in composite restorations. This requires the use of composite formulations that are optically similar to each layer, and sculpting these materials replicates the morphology of each in the area being restored.

**Introduction**

Dental composite technology has advanced significantly over the past decade, while patient demand for esthetic restorations continues to grow. Early systems were segmented into posterior materials that were typically more durable but less esthetic and anterior materials that were less durable but possessed superior color, optics and polishability. The primary evolution of these materials was aided by advances in filler particle technology. Glass and other ceramic filler particles are added to composite resins to increase physical properties such as wear resistance, fracture toughness and shear strength. Early hybrid systems were filled with large, poorly integrated ceramic particles that were subject to loss under the stresses of abrasion; this led to voids within the composite restoration that deteriorated easily, with loss of luster and staining of the composite. Additionally, these materials were very opaque, which parlayed into lifeless, unesthetic restorations and negated their use as anterior filling materials and direct veneers in the esthetic zone. Historically, microfilled composites were favored for anterior esthetic restorations due to their intrinsic translucency and high polishability. The primary filler component of these materials was 0.004 µm fumed silica, which imparted vital optics and polishability but yielded low physical properties and lower strength, making the materials prone to chipping and fracture. Due to their lesser physical strength and properties, the microfilled composites were suitable for anterior restorations only.1

Today, many modern composite restorative materials are considered universal, suitable for both posterior restorative and esthetic anterior applications. Compared to their ancestors these materials possess superior physical properties, come in a full range of vital shades and opacities, and polish to a gloss-like luster. Integral to the success of these systems are the types, size and mechanisms of attachment of filler particles to the resin matrix. Chemical silanation and other coatings now permit more wear resistance and limit particle loss. By varying the composition and types of fillers, particle size and orientation, and the degree of light refraction compared to the resin matrix, manufacturers are now able to offer multiple opacious and translucent shades and polishability that rivals traditional microfilled materials while offering greater strength.

Porcelain fused to metal crowns have been used for cosmetic restorations over approximately the last 50 years. These indirect restorations have had a flat, opacious appearance, and the metal margins often result in a bluish hue at the gingival marginal areas due to shine-through of the metal. These factors led to patient disappointment when these restorations were placed in the anterior zone. Feldspathic veneers have been available for many years as well, but without the ability to dependably bond to dentin and with their often thick, bulky facings, they yield less than optimal results. With the advances in dental adhesion in the last two decades, however, practitioners are now able to bond to both dentin and enamel, and this has opened the door for a wide variety of cosmetic and restorative techniques and materials that duplicate and even enhance nature while also conserving tooth structure. Now termed the “esthetic revolution,” media campaigns and educational literature targeted directly to the public in health and beauty magazines have emerged and patients have become well-informed consumers.

The early phases of the esthetic revolution led to major advances in all-ceramic materials and, along with the expansion of artistic capabilities by lab technicians, creating exquisite smiles became desirable to both dentists and patients. However, it was often necessary to extensively prepare otherwise healthy tooth structure in order to achieve an optimal esthetic result, and with time the demand for conservative alterna-
tives grew. Ultra-thin porcelain laminates have now been developed that require little to no tooth preparation in certain situations. However, these restorations command precise technique, multiple appointments and often high lab fees, which prove to be cost- and time-prohibitive for many patients. All-zirconia crowns are also now available, fabricated in the laboratory or chairside using CADCAM technology. These offer excellent esthetics and, in the case of CADCAM technology, in many cases the opportunity for same-day preparation and restoration. These too, however, can be cost-prohibitive for patients. Recent trends in cosmetic dentistry and the availability of esthetic direct restorative solutions have enhanced the available restorative options.

**Current trends in cosmetic dentistry**

Several factors have contributed to current trends in restorative and cosmetic dentistry. The latest advances in adhesive and restorative materials have led to the ability to use less invasive treatment modalities to yield highly esthetic and durable restorations. The combination of minimally invasive techniques and modern biomimetic restorative materials has proven to be the state-of-the-art solution for practitioners and patients who want to control costs and preserve healthy tooth structure while still obtaining esthetic results. Historically, the restorative material dictated the shape and extent of the preparation. Current concepts permit clinicians to remove or replace only the defective or unsightly area(s) of the teeth and biomimetically restore the area to its original form, function and beauty. While the use of indirect ceramic materials is often indicated, more affordable direct composite materials and techniques are often desirable.

In terms of esthetic dentistry, direct composites offer numerous advantages. Typically, these restorations can be placed in a single visit, often do not require preliminary models or wax-ups, and do not involve lab fees that escalate costs. Direct composite restorations are kinder to the opposing dentition compared to older feldspathic porcelain and, in the event of an unforeseen fracture, they can be repaired easily compared to costly and time-consuming repairs or remakes for porcelain alternatives. The disadvantages of current cosmetic direct composite restorations are few but should be noted. Compared to some indirect porcelain alternatives, most composite materials possess less fractural toughness, shear and compressive strength, and are not ideally suited for ultra-high-stress areas found in certain clinical situations. The presence of unmanaged parafunctional forces such as grinding/bruxism, Class III end-to-end occlusal schemes, large diastemas, or noxious oral habits such as nail biting can potentially jeopardize the longevity of direct composite restorations. Though recent formulations have markedly improved the color stability of these materials, direct composite restorations are not as inert as glazed ceramics and, depending on the quality of polish, are more likely to discolor with chronic exposure to chromogenic foods and beverages. However, with proper case selection, technique, artistry and modern materials, direct composite restorations can yield highly esthetic, lifelike, durable results that can provide patients with many years of service and that can be rewarding to the dentist and patient.

**Contemporary composite materials**

Dentists have always recognized that natural teeth were highly variable in color, and many intuitively used multiple shades of existing body materials in an effort to create more lifelike restorations. Ceramists in the meantime have utilized various opacious and translucent porcelain materials to create depth and vitality and more accurately mimic subtle nuances in the color and translucency of natural teeth. With the expansion of esthetic materials and techniques in the 1990s, early pioneers of artistically placed direct composite restorations and talented ceramists worked closely with dental manufacturers on the development of newer direct systems that were based on the principles of layering ceramic porcelains. Whereas early brands of composite offered only body shades based on the Vita shade guide and appeared dull and dense, contemporary materials offer an expanded range of shades and varying opacities designed specifically for layering of direct restorations.²

Initially, the concept of layering various opacities was foreign to many practitioners, compounded by the lack of a common layering technique and the often esoteric nomenclature used to identify each layering material. Since each brand of material was proprietary and unique to a manufacturer, the layering methodologies advocated were equally diverse. Numerous professional publications, lectures and hands-on courses emerged, demonstrating a multitude of layering concepts and techniques. Practitioners who enjoyed the artistic license afforded by the newer complex kits passionately embraced a complex color palette. However, many argued that the kits were simply too complex and expensive, and the typical fees commanded by these services were not commensurate with the time and effort required to utilize them. Though the foundational requisite and esthetic value of layering was established, more practical and cost-efficient techniques were necessary for mass acceptance among practitioners.

**A logical approach to composite layering**

Direct composite layering is an art form. By nature, the methods and tools of any artistic expression are subject to each artist’s bias and skill and the desired result. A universally accepted direct composite layering technique may not evolve; however, it is hard to refute the basic concept that, in order to replicate the beauty of a natural tooth, one must first understand the basic elements that produce its beauty. Though the eye may visually perceive the various intricacies of color and form of natural teeth, true replication will remain elusive without understanding the impact the histological layers of natural teeth have on their overall appearance.
The anatomy of tooth color

The human tooth is composed of four major tissues: dentin, enamel, cementum and the dental pulp. In direct composite layering, the thickness and coloration of dentin and enamel are of primary concern. As seen in a cross-section of a typical human incisor (Figure 1), dentin is the dominant chromagenic tissue that most influences the overall color of teeth. In the absence of developmental and environmental defects, the entire dentin layer is typically monochromatic in hue and consistent in opacity. However, the degree of saturation or chroma does vary based on age and depth.3 The enamel layer is typically translucent, varies in thickness from the cervical to incisal regions and merely modulates the chroma of the underlying dentin through light scattering at certain wavelengths.4 The external saturation of color seen in the cervical one-third is mitigated by the tapering, thinner overlying layer of translucent enamel, making the more chroma-rich dentin closer to the surface and visible. As enamel thickens towards the middle and incisal two-thirds of the tooth, it begins to desaturate the underlying dentin until dentin ends in the incisal one-third, and the incisal edge is composed entirely of enamel. In the facial plane, the morphology of dentin as it tapers to end in the incisal one-third is highly variable and often undulates in lobes and valleys. (Figures 2, 3) This morphology is significant in that, since enamel is a translucent tissue, the darker oral cavity behind the teeth shows through the valleys devoid of dentin, creating sometimes dramatic bluish to gray zones of incisal edge translucency. An optical characteristic of many natural incisors is the appearance of a white-to-amber glowing edge, often termed an incisal halo. As light passes into the translucent enamel layer, various wavelengths are refracted, scattered and absorbed, and depending on the angle of wear on the incisal edge, commuting light exits the incisal edge, creating the incisal halo.

Another consideration in the anatomy of tooth color is the changes that occur with age. In older patients, the enamel and dentin are thinner, and the incisal edges are more translucent. Additionally, the incisal edges become smoother over time as wear occurs.5,6

The “Histological Layering Technique”

Recognizing the distinction in thickness, color and morphology of natural dentin and enamel, it is necessary to replicate these histological tissues in composite restorations. This requires the use of composite formulations that are optically similar to each layer, and sculpting these materials in a way that replicates the morphology of each in the area being restored. This logical, intuitive methodology has been deemed the “Histological Layering Technique”7 by the author. Similar but often more complex, time-consuming and/or product-specific techniques have been published as the “anatomic build-up technique,”8 the “trendy three-layer concept”9 and the “natural layering concept.”10 The histological layering technique is easy to learn, typically involves only two opacities of material, and applies to all classes of direct restorations and direct composite veneers. Highly esthetic restorations can be predictably created in minutes by any clinician, and this technique can be utilized with most contemporary composite materials. Commonly placed restorations can become seamless, vital works of art with minimal effort, or the technique can be used as scaffolding for more elaborate embellishment when esthetic demands are greater.

The foundational principle of the histological layering technique is that the dentist simply replaces the layer being restored with the corresponding shade and opacity of composite material. If the restoration is contained within enamel, only the enamel material is used. If the restoration
involves dentin, the dentin layer is replaced with dentin material to the dentin-enamel junction, and the enamel layer is replaced with enamel material.

The histological layering technique also applies to direct composite veneers, but with a subtle variation in principle. Most direct composite veneers are placed on teeth with little to no preparation, so technically there are no histological layers to replace. However, it is important to remember that dentin is the most dominant, chromagenic histological layer and is most responsible for the perceived overall shade of a natural tooth. Utilizing this technique involves determining the final, overall desired shade of the restoration(s) and morphologically layering this selected shade of dentin material as the first layer. The second step is to select the corresponding enamel shade that complements the selected final shade and then morphologically place it over the dentin material. If incisal edge translucency is required, dentin “mammelons” can be sculpted in the dentin layer prior to curing, and by placing a translucent enamel material over these undulating dentin lobes, one can replicate these optical effects quickly and easily. If internal pigments such as white hypocalcifications or amber tones are desired, flowable resin tints can be applied to the dentin layer, light cured and overlaid with the translucent enamel. Incisal halos can either be created with proper beveling of the incisal edge, or more dramatically replicated by placing a thin ribbon of bright, bleached enamel material along the incisal edge and sculpting to form.

The histological layering technique can be used with nearly every contemporary composite material that offers a selection of dentin and enamel opacities. Although “opaque” materials are often provided, their use is rarely required with this simplified layering technique. However, in cases where clinicians choose to use a single shade technique in Class IV situations, or in cases where the underlying substrate is severely discolored and must be masked prior to restoring, these opacious materials have merit. One of the first layering composite systems on the market offered a three-opacity system, a full range of dentin body shades and an easy-to-understand nomenclature. Additionally, the system included a proprietary shade guide made of a color-correct denture acrylic in which each tab was layered with three levels of opacity and served to suggest a potential “recipe” to create a polychromatic restoration. Clinicians simply used the proprietary shade guide to match the tooth to be restored or to select the desired result when creating direct veneers, and referred to the labeled tab for the shades of opaque, body and enamel materials to use in the layered restoration. All shade guides are, in fact, “guides.” The underlying substrate can greatly influence the final appearance and can be highly variable in common clinical situations, and the layering technique and thickness of each layer can affect the overall visual appearance of the completed restoration. This must be considered when using any “guide” for shade selection.

Several excellent composite systems are currently available that are highly compatible with the histological layering technique. The resin formulation; filler particle type, size and distribution; handling; ambient working time; nomenclature; certain physical properties; and ease of polish vary among these products. Product preference by clinicians is equally variable due to the inherent, subjective interpretation of proper handling and “ease of use,” and the degree of polish often varies based on the technique and instruments used. Product improvements have included faster and easier handling, improved physical properties and high polishability. The cases below demonstrate restoration of Class III and Class IV defects using the histological layering technique in both a more complex and a simpler technique.

Clinical case: Class IV restoration with the histological layering technique

The patient in this case was an 8-year-old boy who presented with a significant Class IV fracture on tooth #8 due to a bicycle accident. On examination, a large Class IV non-carious defect was present with no pulpal involvement and the tooth tested vital upon endodontic evaluation. (Figures 4a, b) The selected treatment was use of the histological layering technique to place an esthetic Class IV restoration. The shade was selected before starting the procedure, using EsthetX-HD: the “recipe” for the 3 layers is printed on the shade tab for the system. In this case, A-1 is selected which dictates White Opaque (WO), A1 Body, and GE enamel.

Figure 4a. Preoperative facial view of tooth #8

Figure 4b. Selecting the shade
The first step was to create a composite mock-up. This allows the clinician to establish the lingual plane in proper occlusion and enables the creation of a silicone index transferring the occlusion, lingual and facial embrasure. The composite mock-up was created using a body shade of composite, first applying the bonding agent (without first etching the tooth) and then quickly placing the composite over the defect and shaping it first with a plastic instrument and then with a finishing bur. (Figures 5a-d) The focus is to obtain an outline form and lingual occlusion, while the facial contour is of no consequence for the mock-up. Using a mock-up avoids needing to create a free-hand layer class IV and finding out at the end that the occlusion is off and that the restoration requires significant adjustment.

Figure 5a. Initial placement of mock-up composite

Figure 5b. Shaping with a plastic instrument

Figure 5c. Establishing the lingual occlusion and outline form

The next stage was to use a silicone putty to create the silicone index that will transfer the form of the mock-up. (Figures 6a, b)

Figure 6a. Mixed silicone putty placed over mock-up and adjacent teeth

Figure 6b. Silicone index

The mock-up was then carefully removed from the tooth (facilitated by the fact that only the bonding agent was used and no prior etching of the tooth was performed), and the silicone index was then repositioned over the teeth to check its accuracy and ascertain that it was seating positively, had a crisp outline form, was sealing lingually and had set rigidly. (Figure 7a, b) Note that all friable enamel was smoothed and a 1-2 mm bevel was created on all margins.
The tooth was next prepared using a standard etch-and-rinse technique. The etchant was applied to the preparation and surrounding tooth structure for 15 seconds before being rinsed off. The dentin was then dried with an air syringe and left moist, not desiccated. The bonding agent (XP Bond) was then applied in multiple coats over 20 seconds, air volatilized and light cured for 10 seconds. (Figures 8a, b)

The remaining stages involved the creation of the definitive restoration using the histological layering technique. The lingual shelf of the preparation was created first. This involved first lubricating the silicone index with the bonding agent and then placing a thin (1 mm) layer of a very clear shade of composite (in this case, EsthetX-HD Shade CE) into the silicone index on the lingual aspect of the index. Objective is to create as thin and even a layer as possible (0.5 to 1 mm is ideal). This layer must be well adapted to the lingual margin and must leave room for 2-3 layers facial to this shelf. Note that it is important to use a clear shade here as light must be able to communicate through it for vitality. The silicone index with the thin composite layer was then seated over the teeth using firm pressure and the composite light-cured from the labial aspect to form the lingual shelf. After gently teasing the silicone index away from the teeth, the composite lingual shelf was then light-cured from the palatal aspect. (Figures 9a-f)
The transition between the tooth and the restoration was then masked using a highly opaque shade of composite, applying a thin ribbon-shaped amount of this to the seam between the tooth and the restoration area, keeping well clear of the cavosurface area. This layer is adapted against the clear lingual shelf and kept well shy of the facial surface leaving room for both body and enamel shades on top of it. The masking ribbon of composite was then light-cured for 10 seconds. (Figures 10a-c)

Next, the selected dentin body shade was placed over the lingual shelf and over the ribbon-shaped opaque layer using a flat plastic instrument, keeping it just shy of the cavosurface area. The dentin body layer was tapered to the lingual shelf in the incisal two-thirds. There are three key objectives to achieve while creating the dentin body layer: 1) bring the body layer closer to the surface at the fracture margin compared to other areas of the restoration, 2) taper the body layer to the lingual area as the restoration approaches the incisal edge, and
3) create dentin mammelons as required to match the form and translucency on the contralateral incisor, but keeping them shy of the incisal edge. This third objective is especially important in younger patients who have pronounced mammelons. (Figures 11a-c)

Figure 11a. Placement of dentin body layer

Figure 11b. Tapering of incisal two-thirds to the lingual aspect

Figure 11c. Creation of dentin mammelons shy of the incisal edge

After light-curing the dentin body layer, the enamel layer with the incisal halo was created. For this layer, a white shade was selected (in this case, Esthet-X HD “White”). A box on the facial aspect was first created in the dentin layer, prior to placement of the incisal halo composite layer. A small amount of “White” was dispensed and rolled into a ribbon shape, applied to the incisal edge and wrapped slightly along the mesial and distal line angles and light cured. The box created space for the final translucent GE enamel layer, which was next placed over the dentin body layer facially as well as over the incisal halo, creating a translucent layer over the body of the restoration and extending the mammelons with this translucent layer. It was blended at the cavosurface bevel and applied in increasing thickness as it approached the incisal edge. By applying in this fashion, the translucent enamel desaturates the more chromagenic body layer beneath, giving the restoration depth and vitality. The restoration was then finished and polished with a mixture of coarse diamonds for surface texture, along with composite finishing carbides and various grits of sandpaper discs. The final luster was achieved with a buff (Flexi, Cosmedent) and polishing paste (Enamelize, Cosmedent). As demonstrated, use of this three-layer technique results in a highly esthetic, lifelike restoration. (Figures 12a-i)

Figure 12a. Incisal halo on contralateral incisor

Figure 12b. Areas for placement of incisal halo and creation of facial box

Figure 12c. Creation of incisal halo
Clinical case: Class III restoration with the histological layering technique

The patient in this case was a young woman whose chief complaint was the presence of a discolored restoration on tooth #7. On examination, it was found that the mesial Class III restoration was discolored and defective, and that there was a carious lesion disto-palatally in tooth #7. (Figure 13) The selected treatment was use of a simplified histological layering technique using one dentin body shade and one enamel shade. Using a material with good chameleon properties – achieved through the use of specific glass types, particle sizes and distribution – aids in the lifelike appearance and seamless blending of restorations with the surrounding tooth structure. After selecting the shade that best matched the surrounding tooth structure, the carious lesion was prepared and the defective restoration was removed. The preparations were then sequentially treated, first tooth #7 and then tooth #8. After etching the dentin and enamel using the total etch technique, then rinsing and drying, the bonding agent was applied using a cotton pellet and light-cured. With the selected dentin body shade of composite (A2, TPH 3, Dentsply Caulk), an IPC instrument was used to place the cream-consistency composite into the preparation. After light-curing the composite, the enamel shade (YE – yellow-enamel) was then placed over the dentin body shade layer and also light-cured. The same procedure was performed for the adjacent preparation. The preparations were then finished using finishing burs, a polishing disc and polisher for a lustrous, lifelike appearance. (Figures 14-23)
Figure 13. Initial presentation

Figure 14. Preparations completed

Figure 15. Etching of tooth #7

Figure 16. Placement of bonding agent, tooth #7

Figure 17. Light-curing of bonding agent

Figure 18. Placement of dentin body shade of composite (A2)

Figure 19. Placement of enamel shade composite (YE) after curing of dentin body shade

Figure 20. Use of finishing bur on restorations
Conclusion
Recent developments in anterior direct composite restorations have centered around the attainment of esthetic, lifelike restorations. Several techniques are available for these restorations, including single layer and multilayer restorations. The histological layering technique is one of these techniques; it can be used for preparations of all sizes and classes and is suitable for most contemporary systems. Selecting a system that 1) offers excellent handling, 2) has a chameleon effect that enhances the appearance of the restoration by blending into the surrounding tooth structure, 3) offers shades compatible with building a restoration in stages or in two simple steps, and 4) is easy to use in logical steps aids the creation of highly esthetic direct anterior restorations.

References

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Questions

1. The primary evolution of composites was aided by advances in _______.
   a. monomer technology
   b. polymer technology
   c. filler particle technology
   d. all of the above

2. Early composites offered only _______ shades.
   a. “enamel”
   b. “body”
   c. “base”
   d. none of the above

3. Historically, microfilled composites were favored for anterior esthetic restorations due to their _______.
   a. intrinsic translucency and high fracture strength
   b. extrinsic opacity and high fracture strength
   c. intrinsic translucency and extrinsic opacity
   d. intrinsic translucency and high polishability

4. Patient demand for esthetic restorations _______.
   a. continues to decline
   b. has stagnated
   c. continues to grow
   d. none of the above

5. The availability of multiple opaques and translucent shades and polishability has been achieved by varying the _______.
   a. composition and types of fillers
   b. particle size and orientation
   c. degree of light refraction compared to the resin matrix
   d. all of the above

6. Early hybrid systems were filled with _______ ceramic particles.
   a. large, poorly integrated
   b. large, well integrated
   c. small, poorly integrated
   d. none of the above

7. The primary filler component of microfilled composites has been _______.
   a. 0.002 μm fumed silica
   b. 0.004 μm fumed silica
   c. 0.006 μm fumed silica
   d. none of the above

8. The combination of minimally invasive techniques and modern biomimetic restorative materials has proven to be the state-of-the-art solution for practitioners and patients who want to _______.
   a. control costs
   b. preserve healthy tooth structure
   c. obtain esthetic results
   d. all of the above

9. Feldspathic porcelain is _______ compared to direct composite restorations.
   a. kinder to the opposing dentition
   b. easier and less costly to repair
   c. less kind to the dentition
   d. a and b

10. Compared to some indirect porcelain alternatives, most composite materials _______.
    a. possess greater fractural toughness
    b. are ideally suited for ultra-high-stress areas
    c. possess greater shear and compressive strength
    d. none of the above

11. Chemical silanation _______.
    a. permits more wear resistance
    b. is responsible for bonding
    c. limits particle loss
    d. a and c

12. The presence of _______ can potentially jeopardize the longevity of direct composite restorations.
    a. grinding/bruxism
    b. Class III end-to-end occlusal schemes
    c. nail biting
    d. all of the above

13. In direct composite layering, the thickness and coloration of dentin and enamel are of _______ concern.
    a. primary
    b. secondary
    c. tertiary
    d. no

14. _______ is the dominant chromogenic tissue that most influences the overall color of teeth.
    a. Cementum
    b. Dentin
    c. Enamel
    d. none of the above

15. The degree of saturation or chroma of dentin varies based on _______.
    a. age
    b. color
    c. depth
    d. all and c

16. Enamel is _______, allowing the darker oral cavity to “shine through” the dentin mammelons.
    a. opacious
    b. translucent
    c. dichromatic
    d. a and c

17. In the facial plane, the morphology of dentin as it tapers to end in the incisal one-third _______.
    a. is highly variable
    b. often undulates in lobes and valleys
    c. is significant
    d. all of the above

18. Dentin is closer to the surface in the _______.
    a. cervical one-third
    b. coronal one-third
    c. incisal one-third
    d. all of the above

19. As enamel thickens towards the middle and incisal two-thirds of the tooth, it begins to _______ the underlying dentin.
    a. saturate
    b. supersaturate
    c. desaturate
    d. all of the above

20. The incisal halo is created by _______.
    a. refracted light
    b. commutating light
    c. reflected light
    d. all of the above

21. In older patients, the _______.
    a. enamel and dentin are thinner
    b. incisal edges are more translucent
    c. incisal edges become smoother over time
    d. all of the above

22. Replicating the appearance of dental hard tissues requires the use of composite formulations that are _______ similar to each layer.
    a. mechanically
    b. optically
    c. chemically
    d. all of the above

23. The _______ is a layering technique.
    a. anatomic build-up technique
    b. trendy three-layer concept
    c. natural layering concept
    d. all of the above

24. The histological layering technique typically involves _______.
    a. one opaque and one reflector material
    b. two opacities of material
    c. three translucencies of material
    d. b and c

25. Shallow to intermediate dentin is _______.
    a. monochromatic in hue and in chroma
    b. monochromatic in hue but can vary in chroma
    c. multichromatic in hue
    d. none of the above
Questions

26. Using the histological layering technique, if the restoration is contained within enamel then _______.
   a. only the enamel material is used
   b. enamel and dentin material must still be used
   c. enamel and/or dentin material is used
   d. none of the above

27. The histological layering technique applies to _______.
   a. composite restorations and direct veneers
   b. composite restorations and glass ionomer restorations
   c. composite restorations, direct and indirect veneers
   d. only composite restorations

28. Dentin “mammelons” can be sculpted in the dentin layer prior to curing and placement of translucent enamel shade if _______.
   a. incisal edge translucency
   b. incisal edge opacity
   c. incisal edge wear
   d. none of the above

29. If white hypocalcifications are desired, flowable resin tints can be applied to the _______.
   a. enamel layer only
   b. dentin layer
   c. incisal edge only
   d. enamel and cementum layers

30. The first step in the histological layering technique is to _______.
   a. select the enamel shade
   b. select the dentin shade
   c. determine the length of etching time required
   d. all of the above

31. The histological layering technique can be used with _______.
   a. only one
   b. only a few
   c. nearly every
   d. none of the above

32. Incisal halos can be created _______.
   a. with proper beveling of the incisal edge
   b. by placing a thin ribbon of bright, bleached enamel material along the incisal edge
   c. with inversion of the enamel and dentin shades
   d. a or b

33. When restoring a Class IV, opaques _______.
   a. must always be used
   b. have merit
   c. must never be used
   d. none of the above

34. _______ has/have improved composite restorative materials.
   a. Better physical properties
   b. High polishability
   c. Faster and easier handling
   d. all of the above

35. Opacous materials have merit _______.
   a. if the underlying substrate is severely discolored
   b. in Class IV situations
   c. if masking of the underlying substrate is required
   d. all of the above

36. Composite product preference by clinicians involves _______.
   a. objective factors only
   b. subjective factors
   c. the patient
   d. a and c

37. Shade guides are _______.
   a. only ‘guides’
   b. all that is needed
   c. unreliable
   d. none of the above

38. The underlying substrate can _______.
   a. greatly influence the final appearance
   b. be highly variable in common clinical situations
   c. be highly variable in rare situations
   d. a and b

39. Product preference by clinicians is variable due to _______.
   a. subjective interpretation of proper handling
   b. objective interpretation of proper handling
   c. subjective interpretation of ease of use
   d. a and c

40. The creation of a composite mock-up _______.
   a. allows the clinician to establish the lingual plane in proper occlusion
   b. must be performed using only enamel shades for translucency
   c. enables the creation of an index transferring the occlusion, lingual and facial embrasure
   d. a and c

41. An index is made using _______.
   a. alginate
   b. plaster of paris
   c. silicone
   d. all of the above

42. Using a mock-up _______ having to create a free-hand layer class IV.
   a. avoids
   b. sometimes avoids
   c. sometimes necessitates
   d. all of the above

43. When creating a mock-up, a(n) _______ must first be applied to the tooth.
   a. etchant then bonding agent
   b. bonding agent with prior etching
   c. separator
   d. all of the above

44. Using etch-and-rinse adhesive systems with the histological layering technique means that the dentin _______.
   a. must be desiccated
   b. should not be desiccated
   c. must be gauze-dried
   d. none of the above

45. The transition between the tooth and the restoration can be masked using a highly opaque shade of _______.
   a. cement
   b. composite
   c. feldspathic porcelain
   d. all of the above

46. A translucent enamel composite layer _______.
   a. desaturates the more chromagenic underlying body layer
   b. gives the restoration depth
   c. gives the restoration vitality
   d. all of the above

47. Restorations can be finished and polished with _______.
   a. coarse diamonds
   b. composite finishing carbides
   c. various grits of sandpaper discs
   d. all of the above

48. Good chameleon properties in a composite restoration _______.
   a. are achieved through the use of specific glass types, particle sizes and distribution
   b. aid in its lifetime appearance
   c. aid in seamless blending of restorations with the surrounding tooth structure
   d. all of the above

49. _______ can be used to achieve final luster of a composite restoration.
   a. A buff
   b. Stone discs
   c. Polishing paste
   d. a and c

50. The creation of highly esthetic direct anterior restorations is aided by selecting a material that _______.
   a. offers shades compatible with building a restoration in stages or in two simple steps
   b. offers excellent handling and is easy to use in logical steps
   c. has a chameleon effect
   d. all of the above
Esthetic Anterior Composite Restorations

Educational Objectives
1. Describe the development of composite materials and the general changes that have occurred in their properties over time
2. List and describe the advantages that modern anterior composite materials offer for esthetic restorations
3. Define and discuss the anatomical features of the tooth structure and the physical features and appearance of the various components of tooth structure
4. Describe and discuss the use of the histological layering technique for the creation of anterior composite restorations

Course Evaluation
1. Were the individual course objectives met? Yes No

2. To what extent were the course objectives accomplished overall? 1 2 3 4 5

3. Please rate your personal mastery of the course objectives. 1 2 3 4 5

4. How would you rate the objectives and educational methods? 1 2 3 4 5

5. How do you rate the author’s grasp of the topic? 1 2 3 4 5

6. Please rate the instructor’s effectiveness. 1 2 3 4 5

7. Was the overall administration of the course effective? 1 2 3 4 5

8. Please rate the usefulness and clinical applicability of this course. 1 2 3 4 5

9. Please rate the usefulness of the supplemental webliography. 1 2 3 4 5

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?

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