

DEVELOPING NATURAL AESTHETICS WITH DIRECT COMPOSITE RESTORATIONS

Douglas A. Terry, DDS*



Contemporary direct restorations have significantly evolved since their initial development, allowing clinicians to develop natural-looking restorations. Composite resins can be applied for restoration of cavities, anterior tooth reconstruction, core preparation for crowns, splinting, provisionalization, placement of orthodontic brackets, and cementation. The development of hybrid and microfilled composite materials has further improved the clinician's ability to deliver minimally invasive treatment options. This article demonstrates a stratification process in the interproximal and incisal edge reconstruction of maxillary right and left central incisors using a small particle hybrid composite resin to develop an optimal aesthetic result.

Learning Objectives:

This article addresses a direct composite resin technique for development of predictable aesthetics. Upon reading this article, the reader should:

- Comprehend the classification of composite resins by filler particle size.
- Identify the variety of stratification techniques that have evolved to allow development of predictable aesthetics.

Key Words: composite, aesthetic, hybrid, small-particle, minimally invasive

**Faculty member, UCLA Center for Esthetic Dentistry, Los Angeles, California; private practice, Houston, Texas.*

Douglas A. Terry, DDS, 12050 Beamer, Houston, Texas 77089
 Tel: 281-481-3470 • Fax: 281-481-0953 • E-mail: dterry@dentalinstitute.com

The term “composite” represents a multiphase substance formed from a combination of materials that differ in composition or form, remain bonded together, and retain their identities and properties. Composites maintain an interface between components and act in concert to provide improved specific or synergistic characteristics not obtainable by any of the original components acting alone.¹ In dental material technology, the definition of a composite is a “three-dimensional combination of at least two chemically different materials with a distinct interface separating the components.”² The development of the epoxy resin molecule in 1938 by the Swiss chemist, Pierre Castan, and the development and introduction to the world of the first composite resin system by Rafael Bowen were the catalysts of polymer chemistry that have revolutionized modern restorative dentistry. Contemporary composite resin applications in dentistry vary from restoration of cavities, anterior tooth reconstruction, core preparation for crowns, correction of stains and erosion, splinting, provisionalization, placement of orthodontic brackets, and fixed partial denture cementation.³

Classification of Composite Resins by Filler Particle Size

Dental composite resins are comprised of three phases: organic (matrix), dispersed (filler), and interfacial (coupling agent).⁴ Of these three, the alteration of the filler component of the dispersed phase remains the most significant development in the evolution of composite resins.⁵ In dental composites, fillers provide strength and

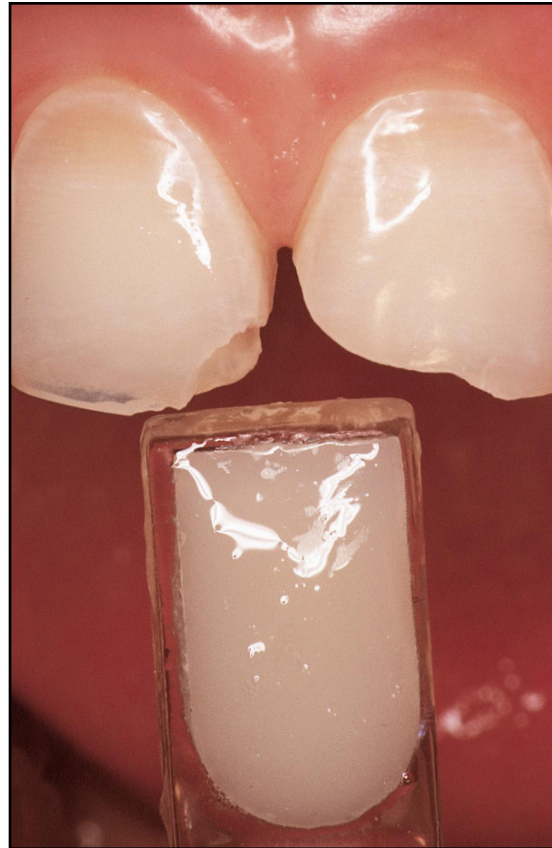


Figure 2. Shade determination was performed prior to rubber dam placement.

reinforcement to the matrix.^{6,12} Fillers include ground quartz, alumina silicate, pyrolytic silica, lithium aluminum silicates, borosilicate glass, and other types of glass that may contain oxides of heavy metals (eg, barium, strontium, zinc, aluminum, zirconium) for radiopaque characteristics.^{13,14} Produced by milling or grinding, precipitation, or through condensation, these fillers vary in particle size depending on the manufacturing process.³ The mechanical and physical properties of composite materials improve in proportion to the volume of filler added.⁶

Numerous mechanical properties — including compression strength and/or hardness, flexural strength, the elastic modulus, coefficient of thermal expansion, water absorption, and wear resistance — depend on this filler phase. The filler particle size, distribution, orientation, and concentration incorporated significantly affects the mechanical properties and clinical success of composite resins,¹⁵ and these characteristics have been the foundation for several classification systems. The evolution in classification systems reflects the changes in the mean

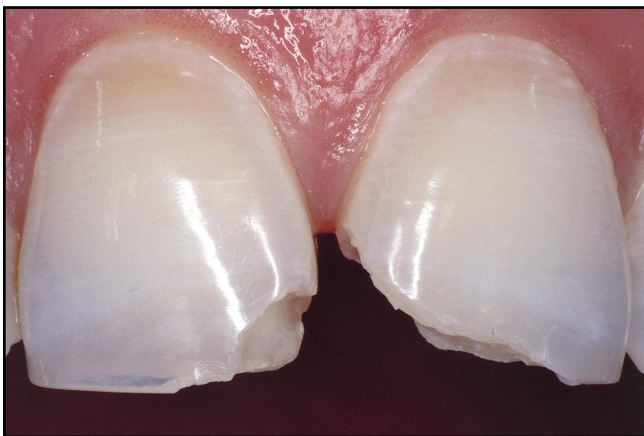


Figure 1. Preoperative facial view of the fractured maxillary right and left central incisors with interproximal caries.



Figure 3. A 0.3-mm deep, 2-mm long chamfer was placed around the entire margin using a long, tapered diamond.



Figure 4. A 0.5-mm scalloped bevel was placed with a long, tapered diamond to break up the straight chamfer line, and the preparations were cleaned with 2% chlorhexidine.

particle sizes of the nonmicrofilled composites and fewer larger particles than the previous generation of composites. Although the common terms (ie, traditional, hybrid, microfilled, fine particle) remain generic, their description varies from system to system.¹⁶

A more simplistic, yet generally accepted approach, subdivides composites into two categories: the hybrid and the microfill. The hybrid consists of several types of filler particles (ie, a glass in the 1 μm to 3 μm range, a 0.04 μm silica, and a radiopaque oxide). Though noted for their strength and polishability, the initial high gloss attained on these composites diminishes with time.¹⁷ Hybrids provide ease of use, refractive indices closer to tooth structure (allowing for blending into the tooth better than those of microfills), and enhanced physical properties. These hybrids exhibit superior tensile strength, improved abrasion resistance, reduced polymerization shrinkage, lower coefficient of thermal expansion, reduced water sorption, and increased fracture resistance due to the amount of inorganic fillers present within the

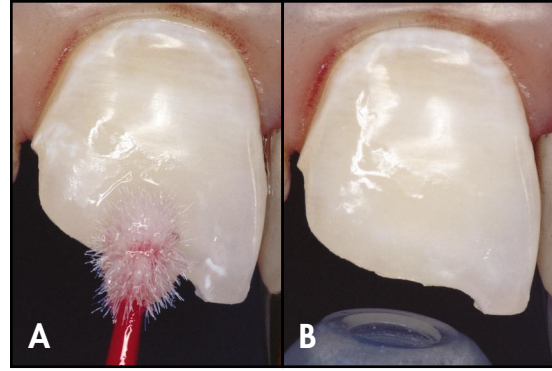


Figure 5A. A self-etching adhesive material was applied. **5B.** A total of three coats of adhesive were placed on the entire cavity surface.

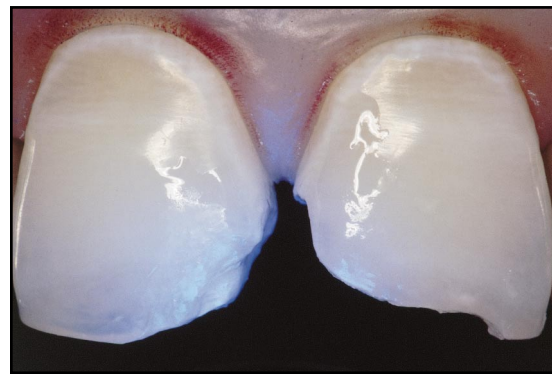


Figure 6. The adhesive was slightly agitated for 30 seconds, lightly air dried, and light cured for 20 seconds.

dispersed phase.^{15,18} As a result, these materials are clinically indicated for Class I, Class II, substructure and incisal regions of Class IV, diastema closures, and direct veneers.

Microfills are composed of submicroscopic silica particles that are approximately 0.04 μm in size (size varies among materials). Producing a homogeneous, nonsticky composite paste requires increased filler particle volume. Agglomeration forms larger groupings of filler by wetting the fillers with resin and polymerizing them together. As a result of the difficulty in wetting these small particles, the filler concentration is limited to approximately 35 wt%.¹⁵ This resin-rich environment provides the restoration with acceptable polishability and the capacity to retain surface smoothness over function.¹⁹ The inadequate mechanical abilities of the microfill include high water sorption, nonradiopacity, the tendency to have lower compressive strengths, fracture resistance stiffness, and fatigue-strength and hardness. Accordingly, these materials are generally contraindicated for high stress bearing restorations (eg, Class IV, moderate to

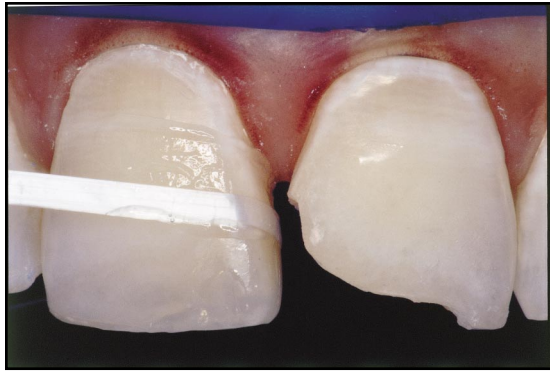


Figure 7. Glycerin was applied to the proximal surface of the maxillary right central using unwaxed floss as a separating medium.

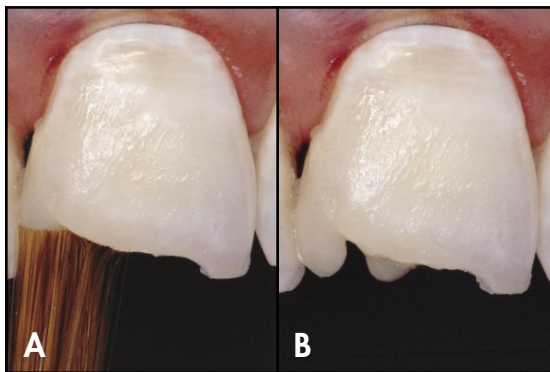


Figure 8A. The first layer of the artificial dentin body, an opacious A-2–shaded hybrid composite resin, was applied, contoured, and smoothed. **8B.** A second increment of opacious A-3–shaded hybrid resin was then placed to form an internal dentin lobe.

large Class I and Class II restorations in occlusal contact with opposing cusps). These composites are indicated for the replacement of enamel in Class III, Class IV, and Class V restorations and direct veneers.

Stratification

In the past, hybrid or microfill concentrations were often combined to achieve a restorative result with optimal physical and mechanical characteristics. The hybrid provided the strength and sculptability, and the microfill furnished the definitive luster and durability of the polish. This incremental layering technique with composite resin resulted in an optimal depth of cure while reducing the effects of the shrinkage and stress forces during polymerization.^{20,21} In addition, the polychromatic effect could be observed when different restorative composites of varying refractive indexes, shades, and opacities were stratified.²² By utilizing an anatomic stratification with



Figure 9. Composite was added to the incisolingual aspect and contoured followed by placement of vertical and horizontal invaginations. The restoration was then light cured for 40 seconds.

successive layers of dentin, enamel, and incisal composite, a more realistic depth of color could be achieved as could surface and optical characteristics that mimicked nature.^{23,25}

The development of polychromatic restorations from the inequities of the different composite resin systems (hybrid and microfill) stimulated scientists, researchers, clinicians, and manufacturers to explore and develop restorative materials that are not only applied in relation to the natural tissue anatomy but also have physical, mechanical, and optical properties similar to that of tooth structure. To date, these modified formulations of microhybrid composite resins are available in different particle sizes, shapes, orientations, and distributions enhancing their physical, mechanical, and optical characteristics. These characteristics provide the clinician with a single restorative material that has sculptability, fracture strength, color stability, polishability, and durability of the polish.

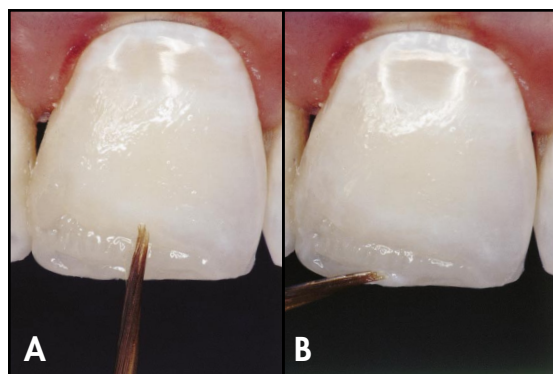


Figure 10A. A diluted yellow tint was placed in the incisal third for chromatic integration. **10B.** A diluted white tint was applied in the horizontal and vertical invaginations and placed across the surface using light brush strokes.

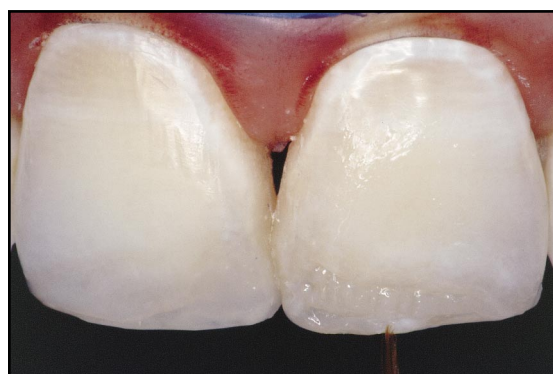


Figure 11. A gray wash was placed in the vertical invaginations to create an illusion of translucency.

This stratification process requires parameters of the restorative materials to only be considered for the specific clinical situation during diagnosis and treatment planning and not the particular region on the tooth or restoration. Therefore, the clinician can consider only the color parameter in developing the correct interpretation of form and color for the restoration.

This article demonstrates a stratification process in the interproximal and incisal edge reconstruction of maxillary right and left central incisors using a small-particle, hybrid composite resin (eg, Venus, Heraeus Kulzer, Armonk, NY; Vit-I-scence, Ultradent Products, South Jordan, UT; Filtek Supreme, 3M ESPE, St. Paul, MN; Point 4, Kerr/Sybron, Orange, CA) to develop an optimal aesthetic result.

Clinical Presentation

A 38-year-old female patient presented with fractured maxillary right and left central incisors with interproxi-

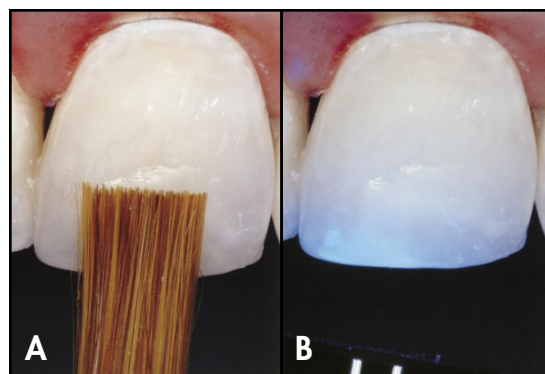


Figure 12A. A neutral, translucent, T-2-shaded hybrid composite was applied, contoured, smoothed with a sable brush, and light cured. **12B.** A yellow translucent T-3-shaded composite was then applied.

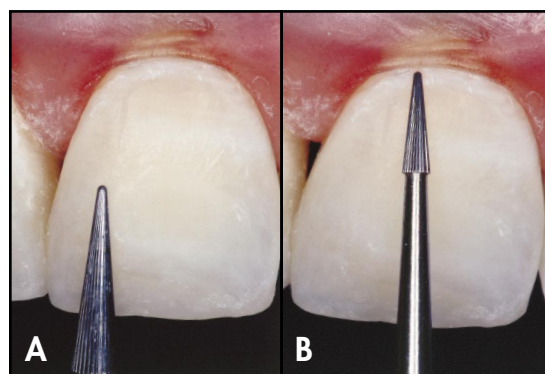


Figure 13A. The initial facial contouring was performed with fluted, needle-shaped finishing burs. **13B.** Gingival contouring was then completed using fluted, short-tapered, straight-edge finishing burs.

mal caries (Figure 1). Clinical evaluation and consultation revealed that the tooth destruction was a result of a habitual consumption of citric acid. The predisposing environment was altered by cessation of the habit and introduction of home fluoride treatments. The proper shades of composite were selected prior to rubber dam placement to prevent improper shade matching due to dehydration (Figure 2).

After anesthesia was administered, the field was isolated using a modified technique to facilitate access to the cervical region of the tooth. This process involved the creation of an elongated hole that allowed placement of the rubber dam over the retainers to achieve adequate field control.^{26,27} The carious dentin was removed with a #4 slow-speed carbide round bur and spoon excavators that produced rounded line angles. A caries-disclosing solution (eg, Seek, Ultradent Products, Salt Lake City, UT; Caries Detector, Kuraray, New York,

NY) was used to detect irreversible infected carious tissue and serve as a guide for its removal.²⁸ The outline form was as conservative as possible without removing healthy tooth structure, unless caries were evident or required extension to a point beyond or within the previously indicated functional stops.

Once the extent of the preparation was determined, a chamfer 0.3 mm in depth and 2 mm in length was placed around the entire margin to increase the enamel-adhesive surface and to allow for sufficient volume of composite at the margins. Using a long, tapered diamond, a scalloped bevel was developed to separate the straight chamfer line (Figure 3). The lingual aspect of the chamfer was extended 2 mm onto the lingual surface, and not on the occlusal contact area. Since the margin was located entirely on enamel, a 0.5 mm bevel was placed on the gingival margin to reduce the potential for microleakage.²⁹ The preparation was finished and polished with a rubber cup that contained a premixed slurry of pumice and an aqueous 2% chlorhexidine solution (eg, Consepis, Ultradent Products, South Jordan, UT; Cavity Cleanser, Bisco, Inc, Schaumburg, IL) to remove potential contaminants (Figure 4).³⁰

The preparation was rinsed and lightly air dried and a self-etching adhesive (eg, iBond, Heraeus Kulzer, Armonk, NY; Clearfil SE Bond, Kuraray, New York, NY) was applied to the entire cavity surface with an applicator tip in 3 separate coats, slightly agitated for 30 seconds, lightly air dried, and light cured (eg, Translux CL, Heraeus Kulzer, Armonk, NY; Optilux 501; Kerr/Demetron, Orange, CA) for 20 seconds (Figures 5 and 6). Each restoration was developed using the aforementioned protocol.

The Interproximal Zone

Since composite does not have hydroxyapatite crystals, enamel rods, and dentinal tubules, the final composite restoration required the clinician to develop an illusion of the way light was reflected, refracted, transmitted, and absorbed by these microstructures. A similar orientation of enamel and dentin was, therefore, required as the proximal surface was re-created. Since a silhouette of the cavity form is highlighted by the darkness of the oral cavity (ie, "shine through"), it was necessary to use an opacous dentin replacement with higher color saturation. To reproduce the optical effects of the enamel, a translucent composite encapsulated the inner dentin core and altered the quantity and quality of the light as it was reflected.

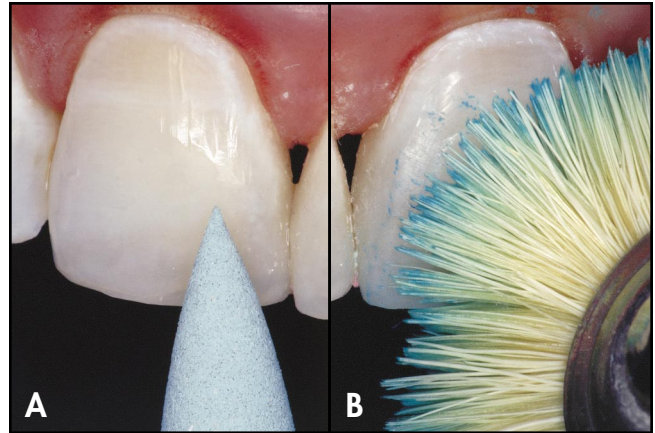


Figure 14A. The final polish was initiated with silicone rubber points to eliminate surface defects. **14B.** Polish was accomplished with a goat-hair brush, polishing paste, and a cotton buff wheel.

Development of the Dentin Layer

An infinitesimal amount of glycerin was applied to the mesial surface of the maxillary right central with unwaxed floss (Figure 7). This "proximal adaptation technique" utilized by the author allows optimal adaptation of the composite resin layer to the adjacent tooth without using a mylar plastic strip. Although the literature has indicated that a smooth surface can be attained with a mylar strip,³¹ improper proximal adaptation may have resulted in inadequate contact, improper anatomical form and shape, or surface defects. Opacious dentin replacement was selected for strength and color, and hybrid and micro-hybrid restorative materials were selected for the core of these restorations. The initial artificial dentin body layer of opacious A-2-shaded hybrid composite resin was applied, adapted, and contoured to the proximal surface of the contralateral central incisor with a long-bladed interproximal instrument and smoothed out with a sable brush (Figure 8A). This process was repeated with a second incremental layer of opacious A-3 composite to form an internal dentin lobe (Figure 8B). It was imperative to monitor the composite material from the incisal aspect to prevent overbuilding that would limit the amount of space available for the final artificial enamel layer. Each increment was polymerized for 40 seconds, which allowed placement of subsequent increments without deforming the underlying composite layer.

An elongated increment of opacious A-2-shaded hybrid composite resin was placed from the incisolingual aspect using a long-bladed composite instrument and contoured to form an incisal matrix. Vertical and



Figure 15. Postoperative appearance using direct composite resin reflects the harmonious integration of the natural tooth structure with the restorative material and color.

horizontal invaginations were placed with a long-bladed composite instrument, smoothed with a sable brush, and light cured for 40 seconds from the facial and lingual aspects (Figure 9). Since surface irregularities could have interfered with placement of the tints for internal characterization, this step was crucial. These invaginations created translucency and provided regions for placement of tints. A thin layer of resin was applied and cured to create a light diffusion layer and provide an illusion of depth for restorations of limited thickness. This translucent layer caused an internal diffusion of light and control luminosity within the internal aspect of the restoration.³²

Internal Color Characterization

In order to re-create the maverick colors in the incisal third, tints and modifiers were applied at different regions of the tooth according to the schematic color mapping diagram (Figures 10 and 11). This technique of internal characterization of tints within the incisal matrix utilized color variation to emphasize the tooth form and instill the definitive restoration with a three-dimensional effect.

Development of the Enamel Layer

The artificial enamel layer represented the principal determinant of the value within the natural tooth or the restoration³³ and could be varied by the thickness of this layer. The colorless enamel functioned as a fiber-optic conduit that projected the underlying dentin color. To re-create the natural translucency of the enamel, a neutral translucent T-2–shaded hybrid composite resin was applied and contoured with a long-bladed composite instrument

and smoothed to create the final artificial enamel layer. This layer was cured for 40 seconds from the facial and lingual aspects, respectively.

The decalcified cervical regions of the central incisors were mechanically removed with a #2 round bur prior to initiation of the adhesive protocol. An increment of T-3–shaded composite resin was sculpted and adapted at the gingival margin and smoothed with a sable brush (Figure 12A). This layer was light cured from the facial aspect for 40 seconds (Figures 12B). An oxygen inhibitor was placed following positioning of the last composite layer prior to the final 2-minute post curing.³⁴

Finishing and Polishing

The final restorative phase was achieved by contouring and finishing the restoration, which was critical to the aesthetics and longevity of the restored teeth.^{35,36} The labial surface was finished with a long, needle-shaped finishing bur that allowed the clinician to follow the proper anatomical contours of the facial aspect (Figure 13A). To replicate natural form and texture, initial contouring and shaping was achieved with an 8-fluted, needle-shaped bur using a dry protocol. A smooth surface was achieved by following a sequential increase in the number of flutes (ie, a #8 was used first, followed by a #16, then a #30). The gingival contouring and finishing was completed with a #8, #16, and #30 fluted, short, tapered, straight-edge finishing bur (Figure 13B). The shape of this bur conformed to the straight emergence profile as the tooth emerged from the gingival sulcus. The lingual surface was contoured and smoothed with #16 and #30 fluted, egg-shaped finishing burs (eg, ET Series, Brasseler USA, Savannah, GA; BluWhite Diamond Burs, Kerr/Sybron, Orange, CA). The shape of these burs conformed to the appropriate curvature of the morphological lingual contours of the tooth and restoration.

Once preliminary contouring was completed, finishing strips were used to refine the interproximal regions. These were used sequentially according to grit and range from coarse to extra fine. For characterization, prepolysh, and high shine, silicone rubber points composed of aluminum-oxide particles that effectively eliminate surface defects were used to establish natural indentations, lobes, and ridges (Figure 14A). The definitive polish and high luster were accomplished with a soft, white goat hair brush with composite polishing paste and a cotton buff using a staccato motion (Figure 14B).

The interproximal areas were examined with dental floss to verify adequate contacts and the absence of gingival overhangs. In order to evaluate occlusion, the patient was placed in an upright position and asked to first perform closure without force and then centric, protrusive, and lateral excursions. Any necessary equilibration was accomplished with a finishing bur, and the final polishing procedure was repeated. The postoperative result achieved with the use of this direct composite resin material reflected the harmonious integration of natural tooth structure with restorative material and color (Figure 15).

Conclusion

Although the long-term benefits of small-particle composite materials remain to be determined, the results described demonstrated enhanced sculptability, the strength of a hybrid, and the polishability of a microfill, combined with the ability to simulate the optical properties of the natural dentition. Recent advancements in restorative materials and adhesive technology have allowed clinicians to combine form, function, and aesthetics for predictable restorative success. This article demonstrated the methodical protocol for interpreting and developing internal depth of color with composite resin. These advances in restorative materials and adhesive technology have enabled the development of direct bonding techniques that allow the provision of conservative treatment and ease the seemingly daunting feat of creating natural-looking restorations.

Acknowledgment

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CONTINUING EDUCATION (CE) EXERCISE No. X



To submit your CE Exercise answers, please use the answer sheet found within the CE Editorial Section of this issue and complete as follows: 1) Identify the article; 2) Place an X in the appropriate box for each question of each exercise; 3) Clip answer sheet from the page and mail it to the CE Department at Montage Media Corporation. For further instructions, please refer to the CE Editorial Section.

The 10 multiple-choice questions for this Continuing Education (CE) exercise are based on the article "Developing Natural Aesthetics With Direct Composite Restorations," by Douglas A. Terry, DDS. This article is on Pages xxx-xxx.

1. The term "composite" represents a _____ substance formed from a combination of materials.

- a. Single-phase.
- b. Double-phase.
- c. Triple-phase.
- d. Multiphase.

2. Which of the following is categorized as a contemporary composite resin application?

- a. Cavity restoration.
- b. Stain and erosion correction.
- c. Orthodontic bracket placement.
- d. All of the above.

3. What are the three phases of dental composite resins?

- a. Organic, dispersed, and interfacial.
- b. Organic, application, and interfacial.
- c. Organic, application, and bonding.
- d. Organic, dispersed, and bonding.

4. Fillers vary in particle size depending on the manufacturing process used (ie, milling or grinding, precipitation, condensation). Despite the volume of filler added, the mechanical and physical properties of composite materials remain unchanged.

- a. Both statements are true.
- b. Both statements are false.
- c. The first statement is true, the second statement is false.
- d. The first statement is false, the second statement is true.

5. What is the approximate size of submicroscopic silica particles?

- a. 0.03 μm .
- b. 0.04 μm .
- c. 0.05 μm .
- d. 0.06 μm .

6. Which of the following is an inadequate mechanical ability of the microfill?

- a. High water sorption.
- b. Low fracture resistance stiffness.
- c. Increased porosity.
- d. Both a and b.

7. Microfill materials are contraindicated for which type of restorations?

- a. Class II and Class III.
- b. Class IV, Class V, and direct veneers.
- c. Class IV, Class I, and Class II.
- d. Class III, Class IV, and Class V.

8. How long should each incremental layer be polymerized in order to allow for placement of subsequent increments without deforming the underlying composite layer?

- a. 40 seconds.
- b. 30 seconds.
- c. 20 seconds.
- d. 15 seconds.

9. The literature has indicated that a smooth surface can be attained with a mylar strip. Improper proximal adaptation can result in inadequate contact, improper anatomical form and shape, and surface defects.

- a. Both statements are true.
- b. Both statements are false.
- c. The first statement is true, the second statement is false.
- d. The first statement is false, the second statement is true.

10. Hybrids exhibit which of the following properties?

- a. Adequate tensile strength.
- b. Increased water sorption.
- c. Improved abrasion resistance.
- d. Minimal fracture resistance.