

# AN INTEGRATION OF COMPOSITE RESIN WITH NATURAL TOOTH STRUCTURE: THE CLASS IV RESTORATION

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*Recent developments in adhesive technologies, the design of composite resin materials, and contemporary placement techniques have revolutionized the delivery of minimally invasive direct restorations. The improved handling characteristics available from low-viscosity flowable systems, packable composites, and sculptable small-particle hybrid composites have expanded today's treatment options. In order to achieve a successful and natural-appearing direct composite restoration, the clinician must have a comprehensive knowledge of adhesive dentistry and an understanding of the optical properties of the natural tooth. This article describes a methodological approach for preparing, restoring, and finishing the maxillary central incisors with a small-particle composite.*

## LEARNING OBJECTIVES:

This article demonstrates the restoration of a Class IV fracture and discusses the anatomic variations of the adjacent teeth to produce a direct composite restoration in harmony with the surrounding dentition. Upon reading this article, the reader should:

- **Be aware of the infrastructure considerations of a composite resin system.**
- **Recognize the role of composite resin on development of natural aesthetics and contour.**

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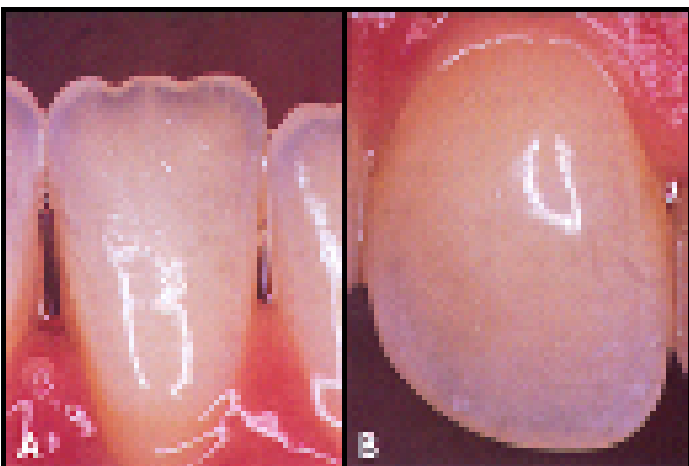
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In composite material technology, the term “composite” refers to a multi phase material formed from a combination of materials that differ in composition or form, remain bonded together, and retain their identities and properties. Composites maintain 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.

Numerous improvements have been made in the design of composite resin materials and placement techniques. Modern adhesive techniques and preparation designs, along with improved handling characteristics available from contemporary composite systems, have expanded today’s treatment options. Composite resin materials can now be used to restore cavities, reconstruct anterior teeth, function as a core preparation for crowns, correct stains and erosion, fabricate provisional restorations, secure orthodontic brackets, and act as a luting cement.

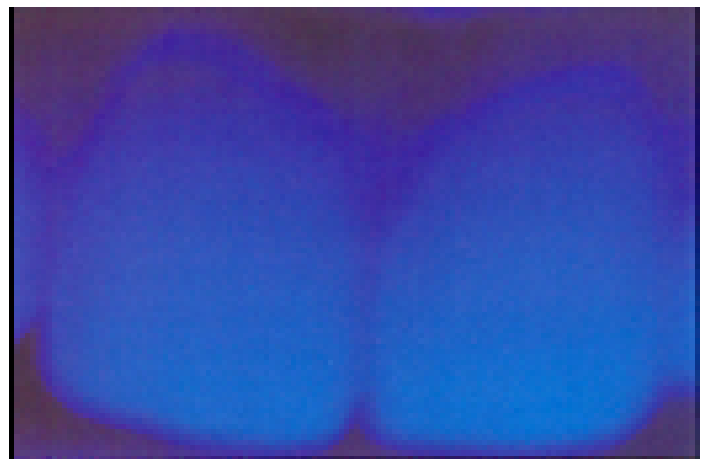
Advancements in restorative materials and adhesive technology have continued to enhance the practice of dentistry. These refinements in material formulations require the use of an adhesive system when considering preparation design, restorative material selection, and placement procedures and techniques. Since resistance and retention are determined primarily by adhesion to enamel and dentin, a more conservative preparation is achievable. This adhesive design concept has been instrumental in the paradigm shift from the principles of extension for prevention to the ultraconservative principle of prevention to eliminate extension.



**Figure 1A.** Aesthetic translucency is evident at the incisal edge and at the mesial and distal incisal angles of the mandibular central incisors. **1B.** Observe the opacity in similar regions on a maxillary right lateral.

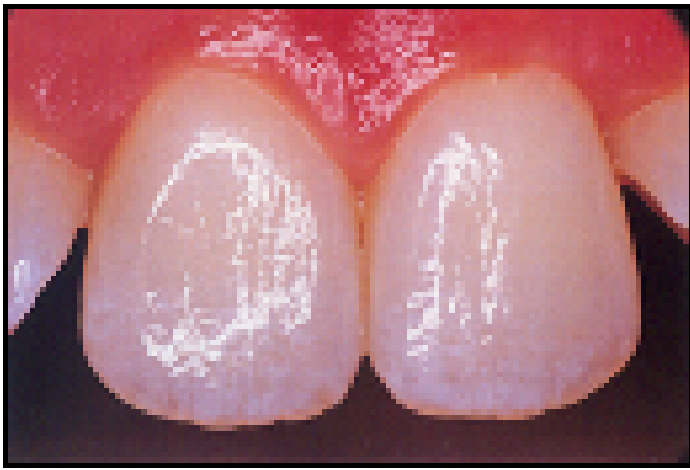


**Figure 2.** The opalescent characteristics of the tooth impart a yellow/orange appearance under transmitted light and a bluish appearance under reflected light.

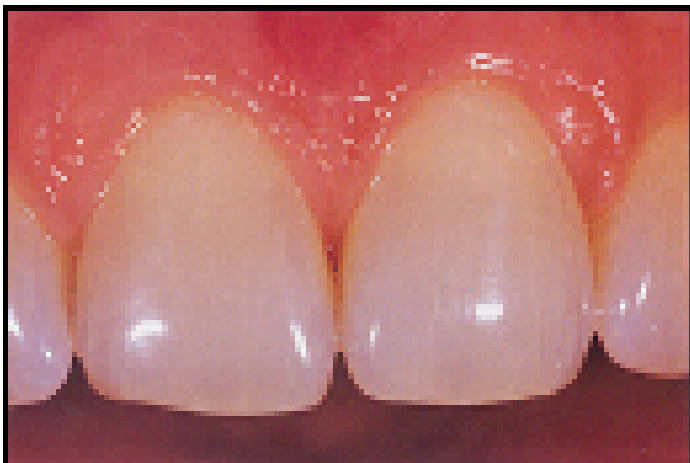


**Figure 3.** Natural teeth exposed to ultraviolet (UV) light rays possess fluorescence with an emission spectrum that varies from intense white to light blue.

These newer formulations of composite resin systems have improved physical, mechanical, and optical characteristics that are directly related to the filler particle size, distribution, orientation, and the quantity incorporated (Figure 1). Prior to the introduction of small-particle composite resins, it was often necessary to combine hybrid and microfilled composites to achieve proper luster, shade, and mechanical stability (eg, strength, wear resistance, and fracture resistance). Although poly chromatic stratification techniques are still necessary, they are used only to attain natural aesthetics and color rather than physical requisites (Figure 2).



**Figure 4.** Surface morphology of natural teeth influences the surface gloss and color perception. Note the diffuse reflection produced by the macromorphologically roughened or coarse surface.



**Figure 5.** A flat or smooth surface allows specular reflection.

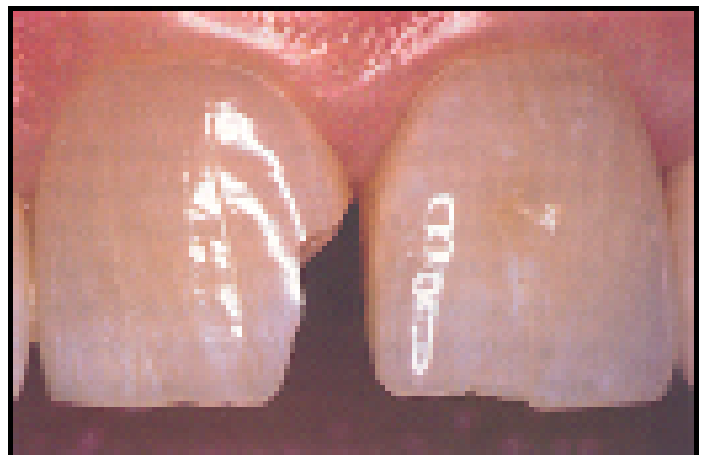
The single anterior tooth replacement represents a complex restorative challenge for the clinician in either composite restorative resins or porcelain systems. The challenge exists while attempting to achieve true harmonization of the primary parameters in aesthetics (ie, color, shape, texture). While porcelain designing relies on stone models, photographs, and the clinician's laboratory narrative description to the technician, direct restorative resin reconstruction relies on the surrounding dentition for correlation. Increased patient demand for optimal aesthetics with less invasive procedures has resulted in the extensive utilization of freehand bonding in the anterior regions. To achieve a functionally successful and natural appearing direct composite restoration, the clinician must have a comprehensive knowledge of adhesive dentistry, including the properties of composite resins, proper tooth preparation techniques, and an understanding of the primary and secondary optical

of the natural tooth and their relationship to anatomical morphology (Figure 3). This case presentation demonstrates the restoration of a Class IV fracture taking aesthetic consideration of the anatomic variations of the adjacent teeth to produce a direct composite resin in harmony with the surrounding dentition. Although stratification techniques are still necessary, by understanding the dimensions of color, the properties of composite resins, and the morphology of the tooth, the clinician will attain more predictable and aesthetic results (Figures 4 and 5).

### Preoperative Considerations

The aesthetic restoration of a single anterior tooth is extremely difficult to perform using porcelain or composite resin. Shade selection should be accomplished prior to rubber dam isolation to prevent improper color matching that may result from dehydration and elevated values. When teeth dehydrate, the air replaces the water between the enamel rods, changing the refractive index that makes the enamel appear opaque and white. By using a pre-visualized mock-up and knowledge of composite materials, the surrounding environment, the modifiers selected, and their shade and orientation, the definitive restoration can be visualized prior to completion. The transformation of this vision into an aesthetic creation that replicates natural variations constitutes the clinician's final challenge.

Consideration of the surrounding environment is crucial for optimal color matching of composite restorations. Composite resin, enamel, and dentin cause considerable light scattering, which produces internal diffusion of incident light and allows the composite restoration to blend with the tooth appearance.



**Figure 6.** Preoperative facial view of the fractured maxillary right and left central incisors.

This blending effect (or chameleon effect) occurs as diffused light enters from the surrounding tooth. When this light is emitted from the restoration it will absorb color from the tooth and alter it. This color alteration depends on the scattering and absorption coefficients, which can produce an undetectable color match by blending with tooth color.

Once the shade analysis has been completed, the appropriate composite material can then be selected. An ideal composite resin should provide color stability, polishability, and sculptability; it should also endure functional stress and produce optimal aesthetics. The following procedure - applied in the restoration of a fractured maxillary central incisor - demonstrates a stratification process that uses the previous accumulated data with appropriately selected composite resins.

### Case Presentation

A 55-year-old female patient presented with fractured maxillary right and left central incisors (Figure 6). The patient requested the most conservative and aesthetic restorative procedure available. An enamel defect was evident in the maxillary left central around the middle one third of the tooth. Shade determination was accomplished using a custom-fabricated shade comparison, instrumental shade analysis (eg, ShadeScan, Cynovad, Montreal, Canada; ShadeEye EX, Shofu, Menlo Park, CA), and previsualized color mapping.

To facilitate access to the cervical region of the tooth, the field was first isolated with a rubber dam using a modified technique. This process involved the creation of an elongated hole that allowed placement of the rubber dam over the retainers to achieve adequate field control. Once the extent of the preparation was determined, a cervical chamfer 0.3 mm in depth was placed 2 mm long around the entire margin to increase the enamel-adhesive surface and to provide sufficient bulk of material at the margins. A scalloped bevel on the chamfer was placed to break up the straight chamfer line with a long tapered diamond (6850, Brasseler USA, Savannah, GA). Since the margin was on enamel, a 0.5-mm bevel was placed on the gingival margin to reduce microleakage with a needle-shaped fine diamond (DET-9, Brasseler, USA, Savannah, GA) (Figure 7). The lingual aspect of the chamfer was extended 2 mm onto the lingual surface, but not onto the occlusal contact area. The margin

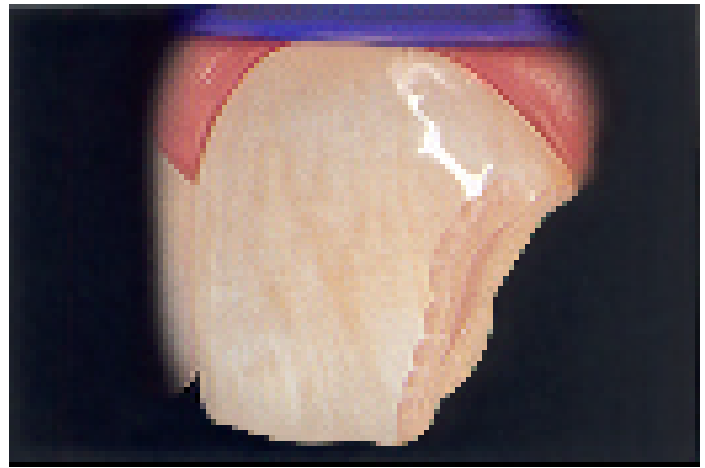


Figure 7. Illustration demonstrates the adhesive preparation design for the Class IV direct composite resin restoration.

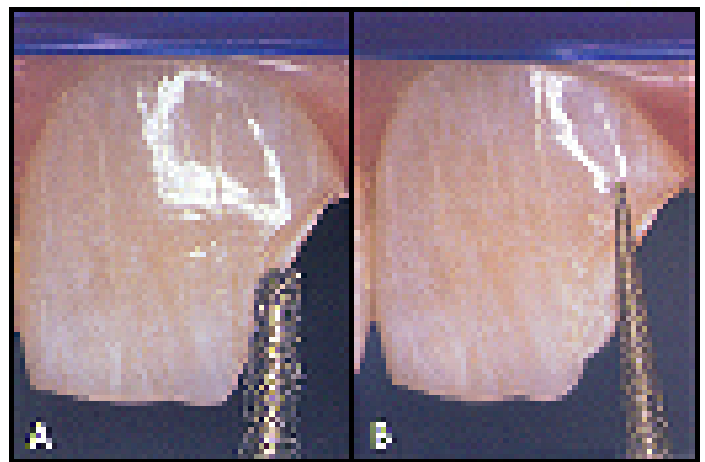


Figure 8A. A chamfer 0.3 mm in depth was placed 2 mm long around the entire margin. Figure 8B. A 0.5 mm scalloped bevel was placed with a long-tapered diamond.

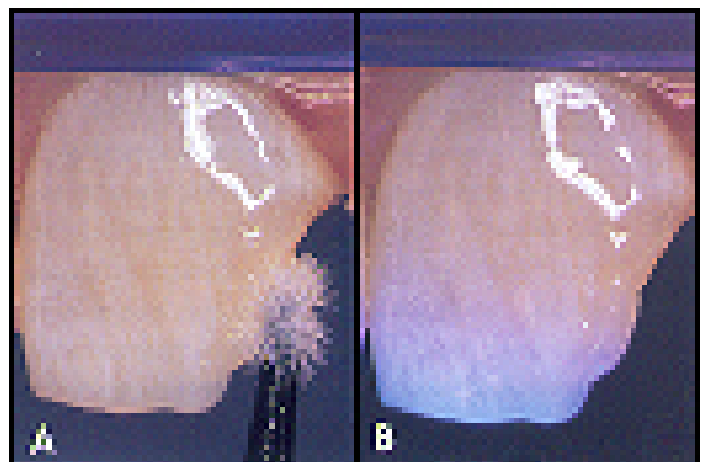
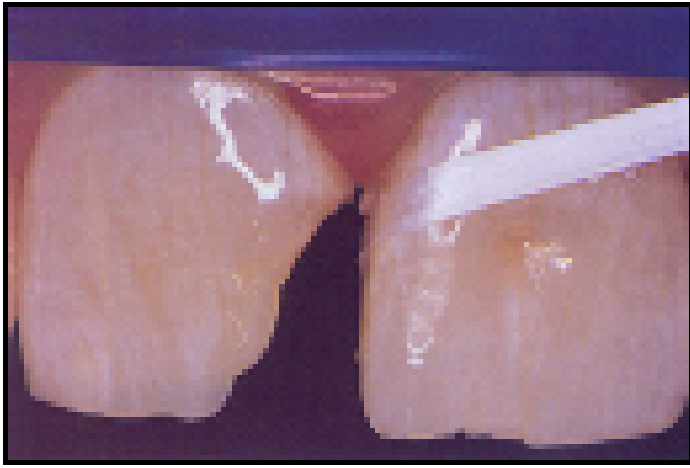
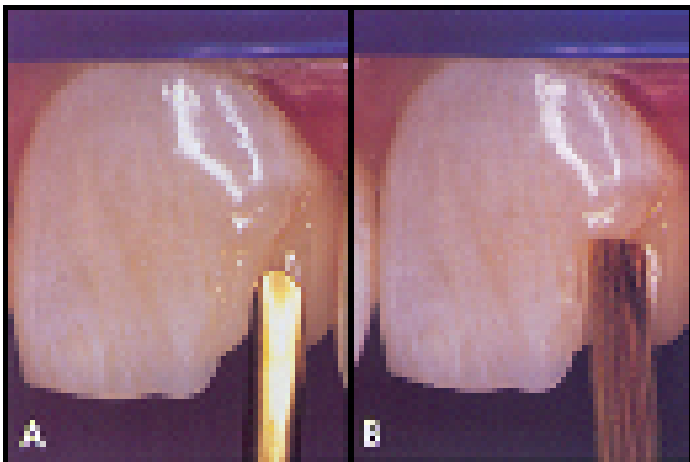


Figure 9A. A self-etching adhesive was applied to the cavity surfaces with an applicator tip and air dried.

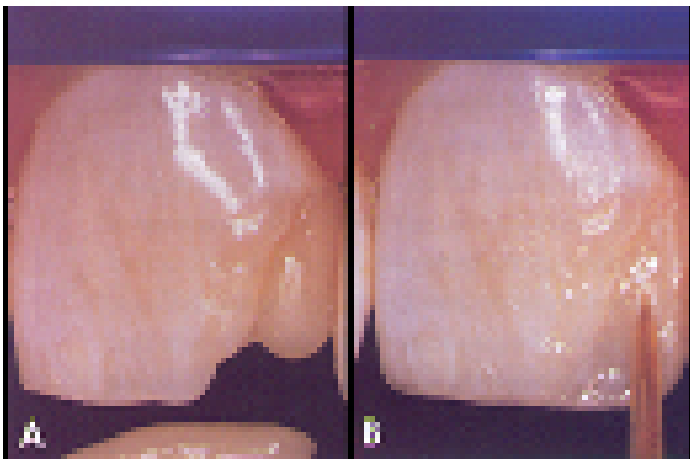
Figure 9B. A bonding agent was applied to the enamel and dentin surfaces and light cured for 10 seconds.



**Figure 10.** Glycerin was applied to the proximal surface of the maxillary left central with unwaxed floss as a separating medium.



**Figure 11A.** The first layer of the artificial dentin body, an opacious AO3-shaded hybrid composite resin was applied and contoured with a long-bladed composite instrument. **11B.** Composite was then smoothed with a #4 sable brush.



**Figure 12A.** An elongated increment of opacious AO3-shaded hybrid composite resin was applied to the incisolin-gual and contoured to form an incisal matrix.

**Figure 12B.** A diluted white tint was applied to specific regions of the restoration using light brush strokes.

should not end on the occlusal contact area unless relocating it to a contact-free area would require excessive reduction of healthy tooth structure. The preparation was completed with a finishing disk and polished with rubber cups that contained a premixed slurry of pumice and 2% chlorhexidine (Consepsis, Ultradent, South Jordan, UT; Tubulicid Red, Dental Therapeutics/Global Dental Products, North Bellmore, NY) (Figure 8). The preparation was rinsed and lightly air dried, and a soft metal strip was placed interproximally to isolate the prepared tooth from the adjacent dentition. A two-component self-etch system (UniFil Bond, GC America, Alsip, IL; Prompt L-Pop, 3M ESPE, St. Paul, MN) was applied to the preparation and light cured (Figure 9).

### The Proximal Adaptation Technique in the Inter proximal Zone

Since composite does not have hydroxyapatite crystals, enamel rods, and dentinal tubules, the final composite restoration requires the clinician to create the illusion of the way light is reflected, refracted, transmitted, and absorbed by these microstructures of the dentin and enamel. Therefore, in recreating the proximal surface, a similar orientation of enamel and dentin is required. Since a silhouette of the cavity form is highlighted by the darkness of the oral cavity, (ie, shine through), it is necessary to use an opacious dentin replacement with higher color saturation. This ensures that when light strikes the optically denser dentin with more color saturation, more light is reflected back to the eyes. To reproduce the optical effects of the enamel, a translucent composite encapsulates the inner dentin core and alters the quantity and quality of the light as it is reflected.

An infinitesimal amount of glycerin was applied to the mesial surface of the maxillary left central with unwaxed floss (Figure 10). The proximal adaptation technique was utilized because it allows optimal adaptation of the initial composite layer to the adjacent tooth without using a mylar plastic strip. Although studies indicate that a smooth surface can be attained with the mylar strip, improper proximal adaptation can result in inadequate contact, improper anatomical form and shape, and surface defects. Opacious dentin replacement was selected for strength and color, and the most suitable restorative material for the core of these restorations was the hybrids and the microhybrids.

Because these small-particle hybrids (eg, Gradia, GC America, Alsip, IL; 4Seasons, Ivostar Vivadent, Amherst, NY; Venus, Heraeus Kulzer, Armonk, NY; Vitalescence, Ultradent, South Jordan UT; Filtek Supreme, 3M ESPE, St. Paul, MN; Point 4, Kerr/Sybron, Orange, CA) have similar refractive properties to that of dentin and a variety of color selections, they imitate the natural tooth structure well and have enough resistance for most occlusal stress-bearing regions in the anterior segment.

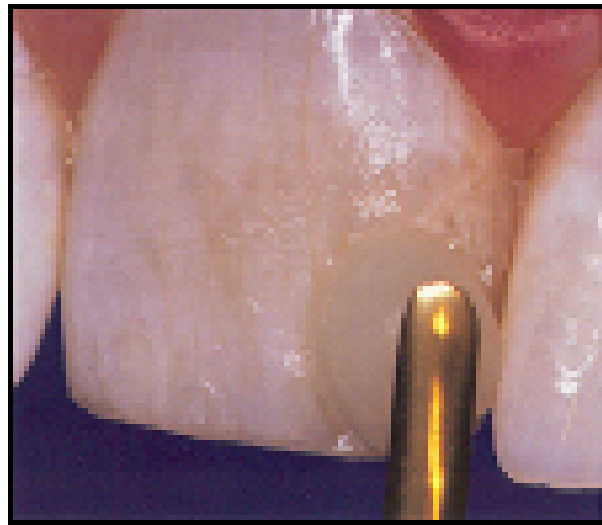
### The Artificial Dentin Core

The initial layer - the artificial dentin body - of opacous A03-shaded composite resin (Gradia, GC America, Alsip, IL) was applied and contoured with a long-bladed composite instrument (TNCVIPC, Hu-Friedy, Chicago, IL) and smoothed out with an artist's sable brush (Figure 11). This step was crucial and each increment was polymerized for 10 seconds, which allowed placement of subsequent increments without deforming the underlying composite layer.

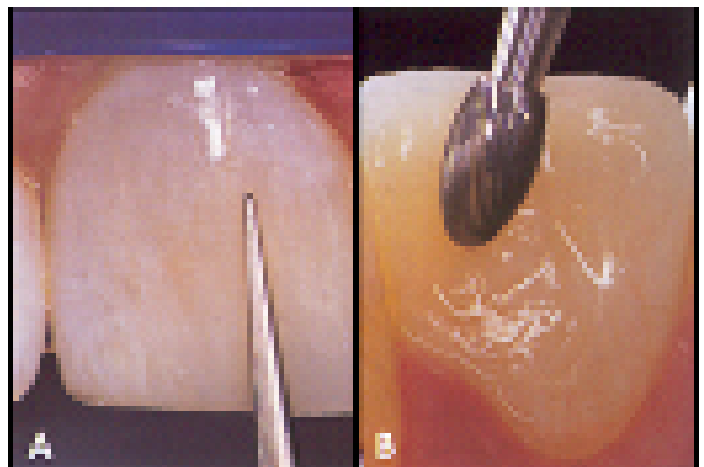
An elliptical increment of opacous A03-shaded hybrid composite resin (Gradia, GC America, Alsip, IL) was placed from the incisolingual aspect (Figure 12A). Since surface irregularities could have interfered with placement of the tints for internal characterization, this step was crucial. To prevent overbuilding of the artificial dentin layer, it is imperative to monitor the composite from the incisal aspect to provide adequate space for the final artificial enamel layer.

### Internal Characterization

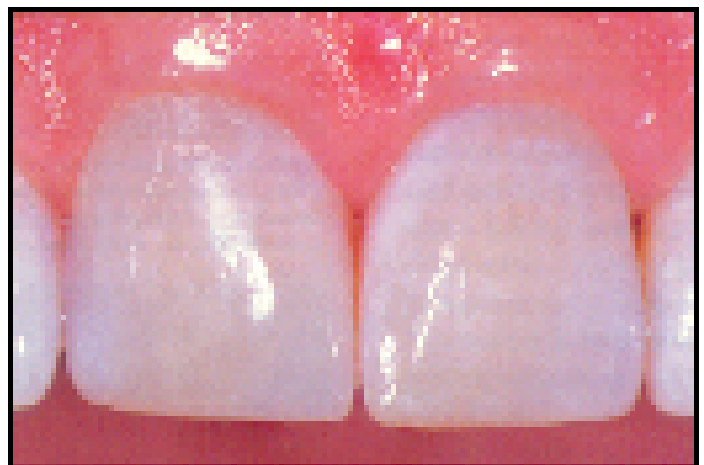
A thin layer of resin (ICO Gradia Intensive Color, GC America, Alsip, IL) was applied and cured to create a light-diffusion layer and provide an illusion of depth. This translucent layer caused an internal diffusion of light and control luminosity within the internal aspect of the restoration. A diluted white tint (IC 9 Gradia Intensive Color, GC America, Alsip, IL) was applied to specific regions of the restoration using light brush strokes to create a cloud effect corresponding to the contralateral central incisor and shade diagram prior to polymerization (Figure 12B). To alter the chroma and disguise the fracture line, a yellow tint was diluted with untinted resin (IC 10 Gradia Intensive Color, GC America, Alsip, IL) and placed along the fracture line and on specific regions in the incisal third. These techniques utilize color variation to emphasize the tooth form and instill the restoration with a three-dimensional effect.



**Figure 13.** A white translucent-shaded hybrid composite resin was applied, contoured and smoothed with a #4 artist's brush, then light cured for 40 seconds.



**Figure 14A.** To reproduce natural form and texture, the initial facial contouring was performed with #30 fluted needle-shaped finishing burs. **Figure 14B.** An egg-shaped bur was used for additional finishing.



**Figure 15.** Postoperative appearance reflects the harmonious integration of composite resin with natural tooth structure.

## The Artificial Enamel Layer

To recreate the natural translucency of the enamel, the artificial enamel layer of white translucent (WT) shaded composite (Gradia, GC America, Alsip, IL) was applied and contoured with a long-bladed composite instrument and smoothed with a #4 artist's sable brush (Figure 13). This layer was light cured from the facial and the lingual for 40-second intervals, respectively. Anticipating the final result and developing the restoration in increments while considering the occlusal morphology and occlusal stops allowed the clinician to minimize finishing procedures and results in a restoration with improved physical and mechanical characteristics with less microfracture.

Once the final layer of composite was placed, and prior to final cure, an oxygen inhibitor (eg, Insure, Cosmedent, Chicago, IL; De-Ox, Ultradent Products, South Jordan, UT) was applied in a thin layer with a brush to the surface of the restoration and light cured for a 60-second postcure from the facial and lingual aspects.

The restoration of the defect in the middle one third of the maxillary left central utilized the previous described self-etch adhesive protocol and an A-3 artificial enamel layer was applied and contoured with a long-bladed composite instrument (TNCVIPC, Hu-Friedy, Chicago, IL) and smoothed out with a #4 artist's sable brush. The same preparation design, adhesive protocol, and restorative recipe as the previously restored maxillary right central was used on the facial and incisal edge of the maxillary left central incisor.

## The Final Restorative Phase

Finishing and contouring was performed to ensure maintenance of a smooth surface texture. In this case, particular attention was given not only to the relationship between the expanse and direction of the marginal ridge, lingual fossa, and the anatomic variations of the teeth that will be adjacent to the restoration, but also to the light refraction and surface reflection resulting from microstructure of the tooth surface. To reproduce the shape, color, and gloss of the natural dentition while enhancing the aesthetics and longevity of the restoration, the following protocol was implemented. A long, needle-shaped finishing bur IET-9, Brasseler USA, Savannah, GA) was used on the labial aspect to ensure development of proper anatomical contours (Figure 14A).

The lingual surface was contoured and smoothed with #16 and #30 fluted, egg-shaped finishing burs (OS 1, Brasseler USA, Savannah, GA) used dry with light pressure to prevent heat buildup (Figure 14B). This dry finishing allowed the clinician to visualize the margins and contours with the adjacent tooth and the shape of this bur conforms to the appropriate curvature of the morphological lingual contours of the tooth and restoration. The interproximal region was finished and refined with silicon carbide finishing strips (Epitex, GC America, Alsip, IL) while contouring and finishing on the proximal, facial, and incisal angles was performed with aluminum oxide disks. These were used sequentially according to grit and ranged from coarse to extra fine. The extra fine finishing disks were used to impart a high luster while maintaining the existing texture and surface anatomy.

The final polish was initiated with pre-polish and high-shine silicone rubber points (Diacomp, Brasseler USA, Savannah, GA) composed of aluminum oxide particles and silicone that permit surface defects to be effectively eliminated. The definitive polish and high luster was accomplished with a soft white goat hair brush with composite paste (Gradia DiaPolisher, GC America, Alsip, IL) and a cloth wheel using staccato motion. The contact was tested with unwaxed floss to ensure the absence of sealant in the contact zone and to verify adequate contact and the absence of a gingival overhang and the margins inspected. The rubber dam was removed and the patient was asked to perform closure without force and then centric, protrusive, and lateral excursions. Any necessary occlusal equilibration was accomplished with #12 and #30 egg-shaped finishing burs and the final polish was repeated. The surface quality of the composite is not only influenced by the polishing instruments and polishing pastes, but also by the composition and the filler characteristics of the composite. The newer formulations of composites with smaller particle size, shape, and orientation provide a level of polishability that compares to porcelain and enamel. Although clinical evidence of polishability with these new small-particle hybrids appears promising, the long-term durability of the polish will need to be evaluated in future clinical trials. Postoperative results reflect the harmonious integration of composite resin with natural tooth structure (Figure 15).

## Conclusion

The clinician's desire to create natural-looking restorations is limited by the products available for restorative procedures. Knowledge must be integrated with the proper technique for each clinical situation. Manufacturers and scientists are leading the way with new advances in restorative materials and adhesive technology. These techniques, concepts, and ideas from clinicians, scientists, and technicians around the world are the spark that ignites the reaction. However, it is the clinical experience and judgment that is the true catalyst of the reaction that creates form, function, aesthetics, and longevity.

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