CORONAL RECONSTRUCTION OF A SEVERELY COMPROMISED CENTRAL INCISOR WITH COMPOSITE RESINS: A CASE REPORT

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ABSTRACT

This article presents the reader with factors to consider when restoring maxillary anterior dentition with direct composite resin veneers. In particular, the restoration of a severely discolored and fractured maxillary central incisor is demonstrated with the use of a direct approach and an integrated system of composite resins that replicate the internal structures of the tooth—specifically dentin and enamel. By observing a systematic layering technique, the reader will become familiar with the manner in which these materials can be manipulated to mimic the shade, properties, color, and form of natural dentition, while promoting responsible esthetics.

The decision regarding which modality is best suited for the patient can only be made following a comprehensive clinical examination that includes an esthetic evaluation and discussion with the patient.

INTRODUCTION

Diagnosing the extent of esthetic and functional compromise of an upper anterior tooth and recommending the ideal treatment is dependent upon judicious evaluations of the clinical situation. In cases of severely discolored and broken down teeth, full-coverage or partial-coverage porcelain restorations have been the standard
treatment for many years, based on their esthetic and strength characteristics. Delegating the artistic result to, and sharing the final esthetic outcome with, a talented ceramist help to alleviate the restorative dentist’s stress and provide a more favorable prognosis. Functionally, ceramic crowns and bonded porcelain restorations have a proven track record substantiated by in vitro and in vivo observations that corroborate their indication.1

Composite resins also have been advocated for decades as a means to conservatively restore minor, moderate, and even large defects. Their indication usually is predicated on the need to preserve as much sound remnant tooth structure as possible while using the synthetic resin composite materials to complete a reconstructive adhesive augmentation. Since the challenges involving retention of such restorations are resolved by implementing sound adhesive techniques, what remains to be mastered in order to provide the utmost in esthetics and longevity with direct composite restorations is properly selecting composite materials, as well as the techniques for their application.

**Indirect Porcelain Versus Direct Composite Restorations**

When deciding between direct composite resin restorations and indirect porcelain restorations fabricated in a laboratory, dentists must address several considerations—some of which are clinical and others more artistic or creative in nature. Although 20 years ago it appeared that weaknesses in direct composite bonding involved the composite material itself,2 manufacturers have made vast improvements to the formulations of direct composites that have resulted in enhancements to their strength, esthetics, and reliability.3 However, direct composite resin restorations still require technique and artistic skills and have limited longevity.3 Although bonded porcelain veneers have demonstrated excellent esthetics,2 they have traditionally required more tooth preparation than for direct composite restorations.3 And, despite the fact that porcelain veneers have shown the best overall survival,4 they also do not demonstrate a permanent life expectancy.5 At a time when patients and dentists alike desire minimally invasive approaches to treatment, the direct composite resin restorations may be more advantageous.

> These composites can be manipulated to conceal or reveal underlying halo, mamelon, translucency, or characterization details to whatever extent is desired.

However, the decision regarding which modality is best suited for the patient can only be made following a comprehensive clinical examination that includes an esthetic evaluation and discussion with the patient.5 Long-term research has demonstrated a 94% survival rate for minimally invasive porcelain veneers,5 and although the use of minimally invasive or no-preparation porcelain veneers can be considered, so should what is best for each patient based upon clinical findings and preferences.

When patient satisfaction with indirect and direct veneers was analyzed, the choice of material (direct composite resin versus porcelain) was not found to significantly affect the patients’ perception of esthetic enhancement.6 However, the results of this research suggest that, when given the choice, patients prefer the option of the more conservative composite veneers.6

Indirect laboratory-fabricated porcelain restorations usually require at least two to three appointments. The responsibility for creating the esthetic results is outsourced to the laboratory. Therefore, the dentist and patient depend upon the ceramist’s interpretation of key information (e.g., shade map, photographs of shade tabs) in understanding the esthetic qualities that are desired, as well as his or her talent in artistically applying ceramics to achieve the anticipated results.

Direct composite resin restorations, on the other hand, afford the clinician complete artistic and creative control over the realization of the restorations. Additionally, these restorations can be completed immediately, without the need for temporization or multiple appointments.

Therefore, as dentists explore the options that are in the best interests of their patients, they must develop a full understanding of the limitations, benefits, and science behind composite resin materials in order to produce highly esthetic restorations that can resist future deleterious effects.7 While the use of direct composite resin enables clinicians to exercise creative control over the restorative process, the successful delivery of esthetic restorations also requires that they have an understanding of natural tooth structure. Equipped with such knowledge, they can then undertake the task of developing their skills in applying appropriately formulated composites to mimic the esthetic properties of natural dentition.
Requisite Knowledge of Tooth Structure for Composite Placement

The perceived color of a tooth is a combination of an inner substrate (i.e., dentin) and an outer substrate (i.e., enamel); this is known as the composite tooth color. Each has intrinsic physical and optical properties. Dentin is approximately 20% more opaque than enamel, providing most of a tooth’s hue, which falls in the red-yellow spectra. Enamel is a fiber optic layer that adjusts the perception of the underlying dentin color. The extent of translucency-opacity of enamel varies based on factors such as enamel thickness, genetics, and age, in addition to treatment factors such as tooth bleaching.

These variations alter the perception of the underlying dentin color, changing its chroma and value. Highly translucent enamel allows light to be transmitted through it to reach a deeper, high-chroma dentin substrate and reflects most of its hue without much change in color saturation. This creates the appearance of an enamel of lower color value. More opaques enamel serves as a barrier that disperses, absorbs, and reflects light such that a minimal amount of color (i.e., hue, chroma) is perceived. Here, an enamel of higher value is created.

Recreating these structures and effects with direct resin requires the use of a composite system that will yield predictable results. Such a system should include shades, opacities, and translucencies that mimic the properties of dentin and enamel. For example, a composite that is to serve as an artificial dentin (AD) is a higher chroma, slightly lower value, opaques composite that mimics missing natural dentin based on its optical and physical properties. Artificial chromatic enamel (ACE) composites are keyd to the VITA shade guide (Vident; Brea, CA) and exhibit a hue with a lower chroma and slightly higher value than the underlying AD composite. The artificial achromatic enamel (AAE) composites are not keyd to the VITA shade guide and are used to impart varying degrees of translucency and subtle hues (e.g., gray, blue, amber), as well as depth to areas such as the incisal third. These composites also may demonstrate milky-white semi-translucent effects in order to replicate the lingual enamel contours (i.e., lingual shelf) and create halo effects.

It behooves the clinician to select a composite system that integrates the requisite AD, ACE, and AAE composites.

AAE composites, which range from translucent to opaques, are used as a final layer to modify or corroborate an existing value of the body enamel, as well as to seal the characterizations and maverick colors underneath. Opaques agents can usually be used in combination with other enamel and dentin layers to modify the value of discolored underlying tooth structure.

When selecting ACE and AAE composites, it is important to note that value enamels are usually of high, medium, or low intensity, and their selection depends upon the brightness and degree of translucency/opalesscence intended over the lobe areas and incisal third. These composites can be manipulated to conceal or reveal underlying halo, mamelon, translucency, or characterization details to whatever extent is desired. The AAE composites also can be applied to alter the perception of the chroma of underlying layers of artificial dentin and body enamel.

Selecting Integrated Composite Systems

Understandably, the restoration of a single maxillary central incisor with a direct composite placement procedure still may prove elusive because of the difficulty in harmonizing form and color within a clinically acceptable time frame. As in all dental procedures, direct composite placement requires a methodical protocol in order for predictable and satisfactory results to be achieved.

Therefore, when faced with such cases, it behooves the clinician to select a composite system that integrates the requisite AD, ACE, and AAE composites. One such system is a new hybrid-based universal composite (Venus Diamond, Heraeus Kulzer; South Bend, IN) that combines low shrinkage and high strength. It is ideal for placing efficient, straightforward, and reliable anterior and posterior restorations that are highly esthetic and lifelike. Further, this ultra-fine nanohybrid composite ensures noticeably better mechanical features. Other direct restorative systems that include a variety of dentin, chromatic, and achromatic enamels include—but are not limited to—IPS Empress Direct (Ivoclar Vivadent; Amherst, NY), Kalore (GC America Inc.; Alsip, IL), Estelite Sigma (Tokuyama America Inc.; Encinitas, CA), and Supreme Ultra (3M ESPE; St Paul, MN).

Available in 23 shades, a two-layer shade guide made from genuine materials facilitates accurate selec-
tion of the most appropriate shade. The material’s “color adaptive matrix” allows restorations to blend seamlessly with the surrounding dentition, and the material’s physical properties contribute to its handling characteristics and high abrasion resistance. Venus Diamond is indicated for restorations for Classes I through V, shape and shade corrections (i.e., diastema closure), core buildups, porcelain and composite repairs, and direct composite veneers, among others.

This article describes the restoration of a severely discolored and fractured maxillary central incisor using a direct approach and composite resins. Shade and material selection are described to promote cohesiveness of color and form.

**Case Presentation**

A female in her 30s presented with a fractured, endodontically treated, and discolored maxillary right central incisor (tooth #8) that showed a defective Class IV restoration (Figs 1a & 1b). The left central incisor (tooth #9) presented a defective Class III restoration on its mesial aspect. Due to the lack of anatomical uniformity, there was a noticeable asymmetry between the two teeth. Radiographic examination confirmed that endodontic treatment had been adequately performed, with no need for re-treatment (Fig 2).

Direct and indirect restorative options were discussed with the patient, including restoration longevity and costs. A direct approach was favored over full- or partial-coverage porcelain restorations, so treatment planning for composite resin restorations was initiated.

**Shade and Restorative Materials Selection**

Due to the large size of the restoration and the functional stress it would undergo, Venus Diamond nanohybrid composite resin was selected. Nanohybrid technology allows for high fracture toughness in stress-bearing areas, while providing more than adequate polishability, characteristics which are desired in the esthetic zone.

Artificial dentin and enamel shades were selected using
customized composite resin shade tabs. It has been reported that there is an overall poor correlation of color between a VITA Lumin shade guide and the actual VITA designation of a composite resin, and that composites undergo significant change in their color and optical properties after light polymerization. Furthermore, the changes are shade and brand-dependent, which makes it very cumbersome to use a VITA or any other shade guide that is not made from the actual composite resin.

This author suggests the fabrication of customized tabs that are 3 mm thick at the cervical third and 0.5 mm at the incisal edge to allow the visualization of color density and opacity gradient. These tabs are made from a putty impression material mold, which is filled with each corresponding shade of composite and light-cured. They can be conveniently glued to a plastic handle to facilitate manipulation.

The shades were selected according to the following criteria:

- ADs to provide opacity, hue, and chroma
- ACEs, which are keyed to the VITA shade guide, to provide hue, chroma, and value to the restorations
- AAEs, which are not keyed to the VITA shade guide, to create effects ranging from translucency to milky-whiteness.

The left central incisor (tooth #9) was used for color reference, and the shade tabs were compared to the respective areas where the colors were observed (Fig 3-5). Due to the
intense discoloration of the tooth, an opaquer (Creative Color, Cosmedent, Chicago, IL) was selected to elevate the low value caused by the pigmented tooth substrate.

A color mock-up was made by layering each shade selected according to the shape and thickness necessary to achieve the intended value change, but still imparting the desired polychromatic nuances (Figs 6a & 6b). The opacity and thickness of the veneer mock-up were evaluated, and any modification deemed important was recorded for the final restoration. A color map (Fig 6c) indicated the layering of each increment according to shade and ideal thickness.

**Preparation Protocol**

Prior to initiating preparation protocol, a silicone matrix was made based on a waxed-up model. This would be used to guide proper composite placement and ensure reproduction of form and occlusion patterns (Fig 7).

The defective restorations then were removed and cavity preparations completed. The right central incisor was prepared with a modified Class IV/veneer design, reducing the facial by approximately 1.2 mm (Fig 8). The Class III preparation consisted of removing the defective restoration and carious le-
Figure 7: A silicone matrix was made based on a waxed-up model and would be used for proper reproduction of form and occlusal patterns.

Figure 8: The defective restoration was removed and discolored tooth substrate was revealed.

Figure 9a: A rubber dam was placed and cavity preparation further completed to preserve a maximum of labial enamel.

Figure 9b: The initial proximal preparation of tooth #9 revealed a fairly deep primary Class III carious lesion.

Figure 9c: A caliper was used to ascertain enamel thickness. Preservation of labial enamel in a Class III cavity depends on enamel translucency/opacity and thickness.
sion (Fig 9a). Following placement of a rubber dam, the cavity preparation was further refined (Fig 9b) and, upon completion of the Class III cavity preparation, the thickness of the remaining enamel wall was measured using a thickness caliper (Fig 9c).

The thicker and more opaque the enamel is, the greater the chance that a halo will not result from optical discrepancies between the natural tooth structure and the synthetic materials. Enamel walls thinner than 1.0 mm on the labial aspect should be evaluated for their translucency and removed altogether to avoid halos that could arise from optical discrepancies. Such preparations should include a longer labial bevel to conceal the tooth-composite transition.

**Composite Placement Technique**

A silicone putty matrix (Zeta Labor, Zhermack; River Edge, NJ) fabricated on the waxed-up model was tried in to verify its precise fit. Then, prophylaxis was performed on both teeth using a mixture of pumice and 2% chlorhexidine. The preparations then were prepared adhesively with a total-etch technique (Fig 10), and a three-step etch-and-rinse adhesive was applied (Fig 11) and light-cured. Specifically, 35% phosphoric acid (Ultra-Etch, Ultradent Products; South Jordan, UT) was used to etch the dentin for 15 seconds and enamel for 20 seconds, after which the three-step adhesive was applied to the dentin and enamel and light-cured for 20 seconds using a light-emitting diode (LED) curing unit.
An AD composite (shade OD) in a higher chroma than the intended enamel chroma was applied to the Class III preparation of tooth #9 and sculpted to conform to the histological boundaries of the natural dentin (Fig 12). This increment of composite was light-cured for 10 seconds. An ACE composite (shade A2) then was applied and contoured to final anatomy (Figs 13a & 13b), after which it was cured for 10 seconds. Finally, an AAE composite (Amber) was applied and contoured to bring the central incisor to its correct mesio-distal width, while also adding volume to the mesial lobe. This layer also was cured for 10 seconds.

The cured restoration was finished to its primary anatomy. The symmetrical mesio-distal widths of both central incisors then were checked using a digital caliper (Dentagauge, Erskine Dental; Marina Del Rey, CA) (Fig 14).27

To facilitate operative access to tooth #8, a #212 clamp (Hu-Friedy; Chicago, IL) was placed (Fig 15). After refining the preparation, the core was entirely in dentin, while the periphery was in enamel.

The prepared tooth was sandblasted with 27 µ aluminum oxide (MicroEtcher, Danville Engineering; San Ramon, CA) to clean the preparation and enhance adhesion (Fig 16).28,29 The enamel was etched for 20 seconds (Fig 17) and the dentin for 15 seconds, after which each was rinsed and excess water aspirated with high vacuum to bring the dentin to ideal moisture. A total-etch, three-step adhesive (Optibond FL, Kerr; Orange, CA) was applied to the dentin and enamel and light-cured (Fig 18).
Figure 16: The prepared tooth was sandblasted with 27 μ aluminum oxide to clean the tooth substrate and enhance adhesion.

Figure 17: The dentin and enamel were etched for 15 and 20 seconds, respectively.

Figure 18: A total-etch, three-step adhesive was applied to the dentin and enamel and light-cured.

Figure 19a: The matrix was positioned against the lingual aspects of both central incisors, and the composite was thinned out to an even thickness of approximately 0.3 mm.

Figure 19b: After the matrix was removed, any excess uncured composite flash was removed from around the gingival area on the palatal aspect.
Then, a 0.5 mm thick layer of an AAE composite (Amber) was applied into the silicone matrix. The matrix was positioned against the lingual aspects of both central incisors, after which the composite was thinned out to an even thickness of approximately 0.3 mm and light-cured for 10 seconds from the labial aspect (Figs 19a & 19b). After the matrix was removed, any excess uncured composite flash was removed from around the gingival area on the palatal aspect, and the thin lingual shelf was further light-cured for 10 seconds from each aspect. This lingual shelf established the proximal contacts and, most importantly, determined the three-dimensional position of the facio-incisal line angle.

The Class IV portion of the defect initially was restored with an AD composite increment (shade OD), which was built out to the labial level of the veneer preparation until it was flush with the tooth contour (Fig 20). This artificial dentin layer was light-cured for 10 seconds.

An opaquer (Creative Color Opaquer A1-B1-LO + Pink) was applied over the AD composite core and veneer preparation (Fig 21) until a higher and even value that matched that of tooth #9 was achieved. Due to tooth dehydration, the value of all adjacent teeth was higher at this point, making it impossible to gauge the correct amount of value change at this time. It was based on the pre-restor-
ative color mock-up that the proper shade and thickness of the opaque were determined.

A higher value, lower chroma AD composite layer (shade OM) was applied evenly over the opaque and up to the incisal third, then cured for 10 seconds (Figs 22a & 22b). This layer promoted an even substrate of elevated value while allowing for the sculpturing of mamelons.

Space was left for the subsequent layers of ACE and AAE composites. In order to impart translucency at the incisal third, a layer of an AAE composite (shade CL) was applied in between and slightly over the dentin mamelons and cured for 10 seconds (Figs 23a & 23b). An ACE composite (shade A2) was applied and sculpted at the cervical third to establish a slightly higher chroma at that area and cured for 10 seconds (Figs 24a & 24b). An ACE composite (shade A1) was applied and sculpted at the middle third (Fig 25) to establish a slightly lower chroma in that area, after which that layer also was cured for 10 seconds.

Tints (Kolor + Plus, Kerr) were used sparingly at the transition between the middle and incisal thirds to emphasize a higher chroma spot, as seen on tooth #9 (Figs 26a & 26b). Blue/Gray tints (Kolor + Plus) were used sparingly at the incisal third to enhance the perception of depth. Then, a final layer of AAE composite (Amber) was applied to cover the entire facial aspect and bring the restoration to final contour (Figs 27a & 27b). This achromatic enamel, also called value enamel because of its role in modifying or corroborating the brightness of a restoration, has the ability to diffuse the light to some extent, while permitting the colors.
Figures 24a & 24b: An ACE composite was applied and sculpted at the cervical third to create a slightly higher chroma at that area.

Figure 25: An ACE composite was applied and sculpted at the middle third to create a slightly lower chroma at that area.

Figures 26a & 26b: Tints were used sparingly at the transition between the middle and incisal thirds in order to emphasize a higher chroma spot, as seen in tooth #9.
of the underlying layers to selectively show though. This layer was cured for 10 seconds.

The clamp was removed, and the central incisors were checked for symmetry (Fig 28). A hydro-soluble oxalate gel was applied to cover the entire restoration, which was then light-cured further for 20 seconds from all aspects (Fig 29). After an initial evaluation of the primary anatomy, coarse Sof-Lex Pop-on XT discs (3M ESPE, St. Paul, MN) were used to establish primary anatomy, and both central incisors were checked with a digital caliper for correctness of height-width proportion and bilateral symmetry (Fig 30).

The restoration was finished and polished with metal (Vision Flex, Brasseler USA; Savannah, GA) and plastic (Epitex, GC America, Inc.; Alsip, IL) strips (Fig 31). They were then buffed and polished with rubber rotaries (Venus supra polishers), and a final polish was imparted using an aluminum oxide paste (Enamelize, Cosmedent) and felt disc. Occlusion and disclusion were checked and adjusted accordingly. The three-month postoperative photograph depicts a harmonious integration of form and color (Figs 32a & 32b).

**Conclusion**

This article has described the restoration of a severely discolored and fractured maxillary central incisor using a direct approach and composite resins. Within the limitations of the techniques represented, it was possible to replicate the internal tooth structures—dentin and enamel—and mimic their natural properties. Key factors influencing composite and shade selection also were addressed to promote
an enhanced understanding of the application of this restorative modality for the restoration of tooth form and color. Minimal tooth preparation and maximum conservation of natural sound tissues were observed, living up to the philosophy of responsible esthetics, while promoting the re-establishment of nature’s biomimetic principles. However, a thorough discussion of all systems and their AD, ACE, and AAE shade designation was outside the scope of this article, and the reader is encouraged to pursue further reading for a broader understanding of restorative composites classification.

References


