"The art of composite bonding is an interdisciplinary modality that incorporates sculpture, design, engineering, architecture, and the dynamics of light to create highly esthetic, seamless, and functional outcomes."

Artistically Emulating Nature with Direct Composite Restorations

Four Clinical Cornerstones for Biomimetic Results

Brian P. LeSage, DDS, FAACD, FAGD, FAAED

Abstract

Composite artistry requires mastery of multiple skills to consistently create lifelike composite restorations. Other factors influencing the success of smile makeovers utilizing directly placed composite include the restorative material's ability to replicate the biological, functional, and esthetic properties of healthy tooth structure. However, also of paramount importance is the clinician's strict incorporation of four clinical cornerstones essential to achieving esthetic, functional, and durable direct composite restorations: starburst bevel, putty matrix, composite scaffolding and multilayering, and finishing and polishing. This article reviews these clinical cornerstones in detail, provides guidance for incorporating them into the clinical protocol for direct composite placement, and illustrates their utility with a clinical case presentation.

Key Words: composite restorations, starburst bevel, putty matrix, composite scaffolding, composite layering, composite finishing and polishing

Introduction

Three-dimensional (3D) composite artistry requires mastery of multiple skills to consistently create lifelike composite restorations. Patients present with smile deficiencies comprising infinite esthetic variables and clinical complexities, for which a comprehensive understanding of every aspect of the case and the selected restorative materials is critical to successfully restore the tooth to an ideal esthetic and functional outcome. The American Board of Cosmetic Dentistry—the credentialing authority of the American Academy of Cosmetic Dentistry—has endeavored to illuminate these variables in its Accreditation criteria sheet.[1] The approximately 40 criteria listed help in establishing an appropriate diagnosis, evaluating case progression, and achieving the eventual restorative outcome.

However, the cited criteria can also be broken down into numerous subcategories, and there is much crossover due to their interrelated nature. Therefore, the success of smile makeovers utilizing directly placed composite is predicated on a combination of factors. These include, but are not limited to, the composite restorative material's ability to replicate the biological, functional, and esthetic properties of healthy tooth structure (i.e., biomimetic dentistry),[2] and the clinician's strict incorporation of four clinical cornerstones essential to comprehensively mastering composite artistry: starburst bevel, putty matrix, composite scaffolding and multilayering, and finishing and polishing.

Material Characteristics, Selection, and Shade Matching

Interdisciplinary Modality

The art of composite bonding is an interdisciplinary modality that incorporates sculpture, design, engineering, architecture, and the dynamics of light to create highly esthetic, seamless, and functional outcomes. Fortunately, in response to the ever-increasing demand for esthetic dentistry, improvements to the physical and mechanical properties, esthetics, and durability of direct composite materials, as well as enamel and dentin bonding systems, have been introduced. Combined, these advances have encouraged and enabled more minimally invasive restorative techniques.[3,4]

Nanocomposites

For example, over the years, resin composites have evolved through generations of traditional macrofilled, microfilled, hybrid, microhybrid and, today, nanocomposites.[5] The latter, in particular, have been cited for their functionality in posterior Class I and Class II restorations, as well as their esthetic applications in anterior restorations.[6] Nanocomposites demonstrate improved mechanical properties (e.g., better compressive strength, diametrical tensile strength, fracture resistance, wear resistance, low polymerization shrinkage) and esthetic characteristics (e.g., high translucency, high polish retention, better esthetics) over their earlier counterparts **(Table 1)**.[7,8]

Table 1. Nanohybrid & Nanofilled Composites

Aelite Aesthetic Enamel	Bisco
Beautifil II	Shofu
Clearfil Majestic	Kuraray America
Empress Direct	Ivoclar Vivadent
Estelite Omega	Tokuyama Dental America
Evanesce	Clinician's Choice
Filtek Supreme Ultra	3M
G-Aenial Sculpt	GC America
GrandioSO	Voco
Harmonize	Kerr
Herculite XRV Ultra	Kerr
Mosaic	Ultradent
Omnichroma	Tokuyama Dental America
Paradigm	3M
Renamel NANO Plus	Cosmedent
Tetric EvoCeram	Ivoclar Vivadent
Venus Diamond	Kulzer
Venus Pearl	Kulzer

Strength, Hardness, and Stability

Interestingly, when choosing a material, compressive strength, diametral tensile strength, flexural strength, and hardness should all be considered. Additionally, a critical characteristic of esthetic restorative materials is their long-term color stability; the primary reason patients request replacement of a composite resin restoration in the esthetic zone is an unacceptable color match. Therefore, an esthetic criterion of the selected restorative material is its ability to mimic the appearance of natural tooth color by considering and assessing the initial color match, as well as color stability after prolonged exposure in the oral environment.[9] Note that a composite's color stability is dependent upon the material's resin matrix, filler particle dimensions, depth of polymerization, and coloring agents.[10-12]

Opacity, Translucency, and Light Reflection

However, a challenge to shade determination and color matching is establishing a balance between opacity and translucency during the smile restoration process. A highly opaque material will block all light and prevent dark dentin color from showing through underneath. Unfortunately, highly opaque materials will neither absorb nor reflect sufficient natural light for the restorations to appear pleasingly dynamic and lifelike.

Additionally, if the selected restorative materials differ in value, chroma, or hue compared to the natural tooth, an obvious esthetic mismatch at the tooth–restorative interface will result. Even if a perfect shade match is achieved, the margins likely will be visible because resin absorbs and reflects light differently than enamel over dentin.[13]

Clinical Guidance: To prevent dehydration during initial shade selection and shade reproduction:

1. *Take shade tab photographs prior to teeth dehydration.*
2. *Take photographs with a triangular, wedge-shaped increment of composite on the teeth/tooth.*
3. *Use a spectrophotometer for shade analysis of the teeth/tooth.*
4. *Color-map using the above information.*

Clinical Cornerstones for Emulating Nature

To comprehensively master 3D composite artistry and achieve an ideal overall esthetic outcome, it is essential that dentists incorporate four clinical cornerstones into their direct composite restorative protocol. These clinical cornerstones (demonstrated here on typodonts, in illustrations, and in clinical images), include a starburst bevel, putty matrix, composite scaffolding and multilayering, and finishing and polishing.

Starburst Bevel

A starburst bevel, described initially by the author in 2007,[14] creates a gradual transition between tooth structure and all resins.[15] This transition enables visual blending or imparting a chameleon effect between the esthetic characteristics of the two materials (e.g., tooth structure and restorative material), eliminating the visible margin.[16,17] Its proper use is crucial to producing a restoration that is invisible to the eye.

The starburst bevel is created with bevels that differ in depth, length, and volume. This undulated bevel facilitates blending resin and enamel so that when light transmits through the resin, it also interacts with the enamel, thereby camouflaging the fractured edge **(Figs 1 & 2)**.

Clinical Guidance: Create a starburst bevel on the facial aspect and a shoulder margin on the lingual.

Figure 1: View of a starburst bevel incorporating a conventional 30-degree bevel and additional bevels of varying depths, lengths, and volumes.

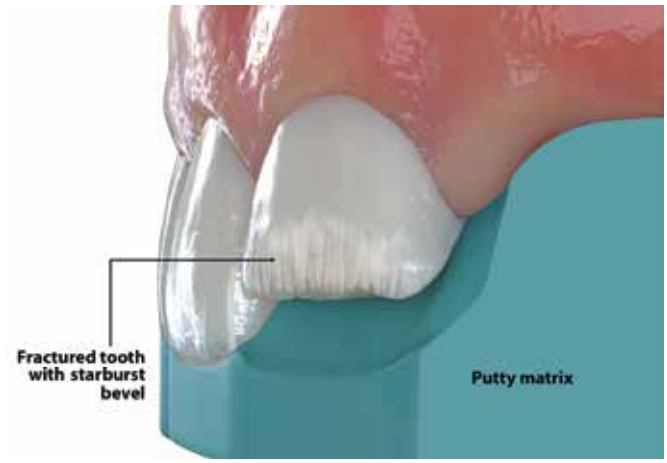


Figure 2: The completed starbust bevel and the putty matrix properly trimmed to the facial incisal line angle.

"...these advances have encouraged and enabled more minimally invasive restorative techniques."

Putty Matrix

A putty matrix, made directly or indirectly from a diagnostic mock-up using polyvinyl siloxane material, must be precisely trimmed to the facial incisal line angle. The putty matrix serves as a 3D blueprint for initiating the lingual scaffolding of the lingual enamel to subsequently apply the dentin, translucent, tints, and enamel composite layering increments **(Figs 3a & 3b)**.[18] Other anatomical features and characteristics (e.g., dentinal lobes, translucency, incisal halo, facial enamel) also can be developed from this initial lingual shelf or scaffolding **(Figs 4a & 4b)**.

Clinical Guidance: Fabricate the putty matrix off of a direct or indirect mock-up of the tooth/teeth to be restored. Trim the putty matrix to the facial-incisal line angle.

Composite Scaffolding and Multilayering

Composite layering is the third crucial clinical cornerstone of 3D composite artistry. Layering composite restorations for enhanced esthetic outcomes progressed from the development of light-curing technology and the introduction of comprehensive, multishaded enamel, dentin, and effect direct restorative materials. These optically structured composite systems offered a variety of opacity, translucency, hue, and chromatic shades **(Figs 5-7)**.

Today, successfully incorporating esthetic composite systems depends on a dentist's understanding of layered materials, combined with artistic and skillful application of architectural concepts, in order to emulate natural dental anatomy and optical properties. This can be achieved by following the author's 3D Characterized Layering Technique, which was first described in 2007.[14] Ranging from simple placement to more advanced layering concepts, this 3D technique begins by using the putty matrix to establish the lingual enamel, then progresses to building dentinal lobes as visualized from the natural dentition.

The shade for the dentin lobes is determined from the gingival third of the tooth, where the enamel is thinnest **(Fig 8)**. The dentin lobe topography, which is established in the incisal third of the tooth, leaves zones for translucent shaded composite to be placed **(Fig 9)** (note that the correct incisal translucency and halo effect must be established in this area). Tints can be applied sparingly to create maverick coloring **(Fig 10)**. The final outer layer of facial enamel composite, determined from the middle third of the tooth where the enamel is thickest, must be a homogenous layer that covers the entire facial surface of the tooth **(Fig 11)**.

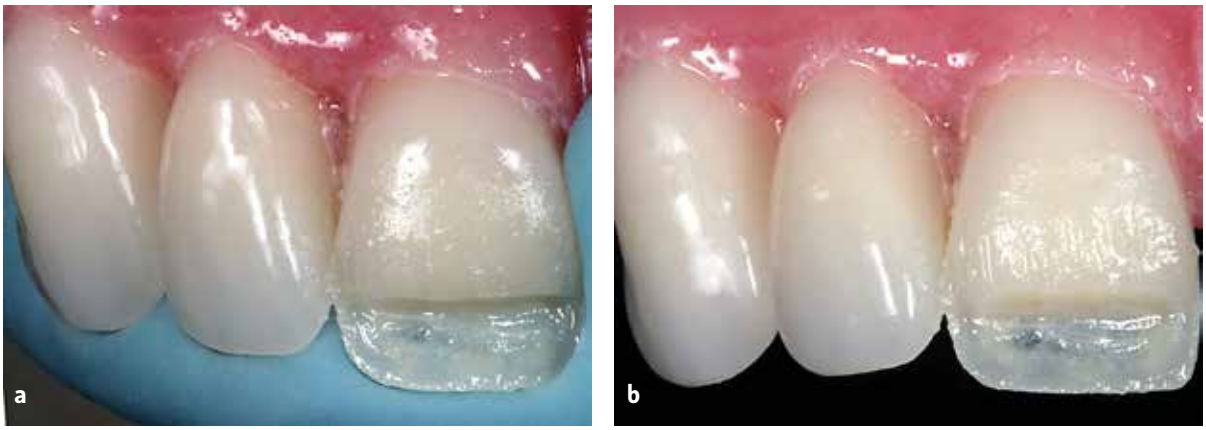
Clinical Guidance:

1. *Etch the enamel past the end of the starbusrt bevel, and the dentin, for 20 to 30 seconds, then rinse for 10 seconds.*
2. *Apply 2+ coats of universal adhesive for 30 seconds; air dry until nothing moves; then light cure.*
3. *Place a thin (e.g., 0.5 mm) increment of enamel shade composite into the putty matrix, being sure to include the entire incisal edge; place the putty matrix onto the tooth, ensuring that the composite contacts the lingual surface of the tooth to be restored, and light cure for 20 seconds.*
4. *Place a more opacious or chromatic shade of composite to mimic the dentin shade of the tooth. Build irregular dentinal lobes that blend apically into the starburst bevel—but do not fill them—and stretch to reach the incisal edge. Light cure.*
5. *Apply a translucent or enamel effect shade of composite to fill in between the lobes and also into the interproximal transition zones, then light cure.*
6. *Apply tints, always white, internally (e.g., below or on top of the translucent zone) to mirror the maverick coloring of the natural teeth.*
7. *Cover all prior layers of composite and 2 mm to 3 mm beyond the bevel with an enamel shade that will modulate the value of the restoration, then light cure for 2 to 3 cycles of 20 seconds from the buccal and lingual aspects.*

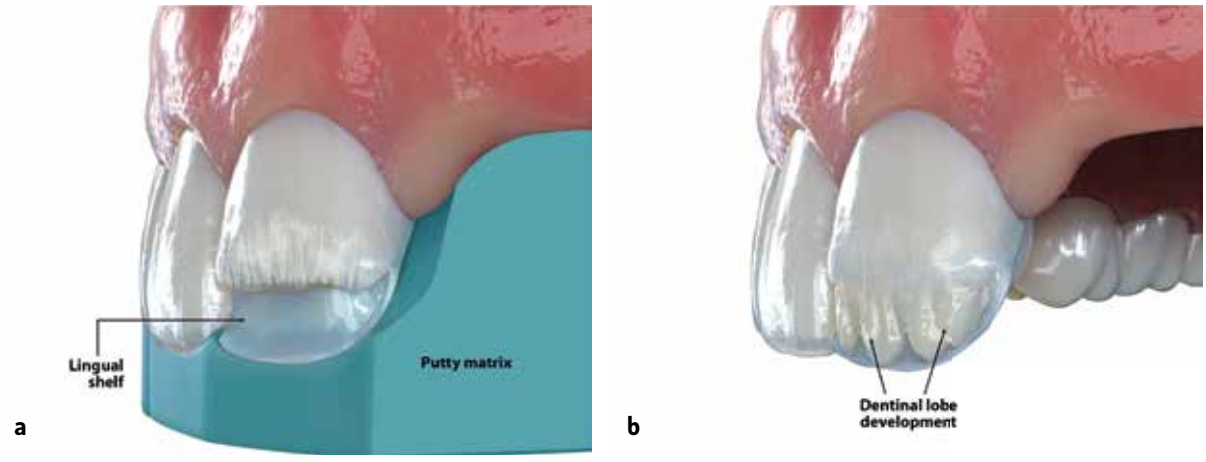
Finishing, and Polishing

Morphology and surface finish: Finishing and polishing, the fourth clinical cornerstone essential for successful direct composite restorations, are both material- and technique-sensitive. To achieve a highly esthetic and durable restoration, a topographically correct surface is clinically necessary. Morphology and surface finish that are clinically correct for an esthetic outcome help to prevent staining, plaque retention, gingival irritation, recurrent caries, abrasiveness, wear kinetics, and tactile perception by the patient.[19,20]

Primary, secondary, and tertiary anatomy: Each patient has their own unique and specific tooth luster and polish, and each tooth has its own primary (i.e., general shape or outline form), secondary (i.e., peaks and valleys), and tertiary (i.e., texture, dots, and lines) anatomy. *Contouring* is the artistic act of gross reduction to obtain the required restorative anatomy and outline form. Changes are made to areas that reflect or disperse light, thereby improving the smile's esthetics. Start with a coarse or medium disc to correct the incisal edge plane **(Fig 12)**. The goal is to mirror the adjacent tooth. A coarse disc moves the line angles toward the interproximal area **(Fig 13)**. A medium-grit disc can be used to begin the finishing and polishing by removing any remaining imperfections and scratches. Finally, a red flame-shaped finishing diamond is used to make minor adjustments by moving the line angles toward the center of the tooth, creating the appropriate curvature to the line angle **(Figs 14 & 15)**. Following this sequence will impart a high polish to the restoration.



Figures 3a & 3b: (a) The lingual enamel layer is established by placing a small, thin increment of composite into the putty matrix intimately against the tooth and light curing. (b) This lingual scaffolding is a precise starting point for the 3D composite layering technique.



Figures 4a & 4b: (a) To initiate 3D scaffolding of the composite restoration, a very thin increment of the selected enamel shade is placed in the putty matrix. (b) Dentinal lobe development.

Figure 5: Translucency is established by placing the appropriate thickness of translucent or enamel composite.

Figure 6: Natural characterization is achieved by applying white tints (and other colors) as maverick colorization to mirror adjacent dentition.

Figure 7: The selected enamel shade, when placed in the appropriate thickness, ideally modulates the value of the final restoration.

Tips

Beginner

- Select a composite kit with a full complement of shades (e.g., A, B, and D) that ideally includes multiple dentin shades.
- For anterior restorations, use a minimum of two composite shades (i.e., a dentin shade with more chroma for the first layer deep in the tooth, and a shade with less chroma or higher value for the outer enamel layer).

Intermediate

- Take before and after photographs of all your cases, and use these as a basis for improving your contouring and color-matching skills.
- Use rubber dam isolation, but be aware that the teeth will dehydrate.

Advanced

- Perform detailed color-mapping and photography prior to rubber dam placement and tooth dehydration.
- Incorporate more advanced 3D characterized layering techniques.
- Follow the contour, polish, and high finishing (sheen) sequence to create texture and luster appropriate for the specific patient's dentition.

Figure 8: A more opacious/chromatic shaded composite layer—which should be applied upward onto the starburst bevel to block out the fracture line—creates the dentinal lobes.

Figure 9: A translucent composite layer is placed to fill in between the dentinal lobes and interproximally in the transition zones, but does not fill the starburst bevel.

Figure 10: A tint or characterization layer creates maverick coloring, where needed, to replicate the patient's natural dentition.

Figure 11: The final layer of facial composite is applied to cover all prior composite layers and onto the natural tooth beyond the starburst bevel.

Figure 12: A coarse or medium disc creates the incisal edge plane.

Figure 13: A coarse or medium disc moves the line angles from the center portion of the tooth to the mirror position on the contralateral tooth (the red marks indicate where the outer facial enamel layer establishes the line angle; the solid blue line indicates where it should be moved to mirror the contralateral tooth).

Figures 14 & 15: A red flame-shaped finishing diamond moves the line angles toward the center of the tooth.

Figure 16: Following appropriate finishing and polishing, the definitive restoration demonstrates the ideal sheen and luster, with natural-looking translucency, incisal halo effects, and lifelike characteristics.

"To achieve a highly esthetic and durable restoration, a topographically correct surface is clinically necessary."

Finishing is the process of refining the roughness or minimizing the micro scratches typically created during contouring.[21,22] *Polishing* imparts a high sheen and further eliminates micro scratches, creating a satin finish, lower luster, or high sheen, depending on the tooth being replicated.

Imparting realism: Various finishing and polishing techniques and systems are available for imparting realism in direct composite restorations, thereby enhancing a patient's smile **(Fig 16)**. Removal of excess material and recontouring is performed first, using any of a variety of coated abrasive discs, carbide burs and stones, fine finishing diamond burs, and resin- or silicone-impregnated burs.[23] Seamless and invisible margins are effectively achieved when fine, extra-fine, and ultra-fine finishing diamonds are used.[23] A polishing system that includes polishing discs, points, cups, wheels, silicone brushes, goat hair brush with a chamois in the middle, and polishing paste should be used to achieve the appropriate luster and polish, as well as patient-specific variations in surface roughness, topography, and sheen.[22,24]

Clinical Guidance:

1. *Begin contouring using a coarse disc to create the facial planes and incisal edge plane.*
2. *Use a red flame-shaped diamond to create line angle positions.*
3. *Use pencil lines and smudged articulator paper to reveal and confirm the topography and reflective surfaces on the facial anatomy.*
4. *Apply texture using a coarse diamond on a low speed.*
5. *Polish with medium and fine discs, and/or rubber points and wheels.*
6. *Reapply texture, then use a goat hair brush with composite polishing paste at low torque and firmness, followed by higher speed and less pressure.*

Clinical Case

A 32-year-old patient presented with an existing composite restoration on tooth #9 that he received when he was 12 to treat a Class IV fracture. The additive restoration comprising the incisal one-third of this anterior tooth did not blend with the natural tooth structure or the adjacent teeth **(Figs 17a & 17b)**. The patient requested a more esthetic and natural-looking restoration.

Shade Selection

To select the best shade, three triangle-shaped wedges in varying degrees of thickness with high chroma, translucency, and enamel shade were placed on the tooth and light cured **(Fig 18)**. Selecting the right hue, chroma, and related value based on the thickness of composite is critical as thickness determines how light will reflect, absorb, and transmit off the composite to establish the correct shade.

After shade-taking and color-mapping, rubber dam isolation with ligation was established **(Fig 19)**. Conservative removal of the composite was initiated, and after removal of 1 mm to 1.5 mm, it was determined that the existing composite shade would work well as the dentin substrate and lingual scaffolding.

Layering

Due to the transition between the existing restoration and tooth structure, a minimal starburst bevel was placed **(Fig 20)**, which served as the starting point for the 3D composite artistry. (In most cases the entire composite would be removed, but that was not necessary in this case. However, the same protocol would be followed.) In the present case, routine etching (Etch-37 w/BAC, Bisco; Schaumburg, IL), universal adhesive application (All-Bond Universal, Bisco), and curing (Demi Plus, Kerr; Brea, CA) were performed to initiate bonding **(Fig 21)**, and white tint (Estelite Color, Tokuyama Dental America; Encinitas, CA) was added as maverick coloring to mirror the contralateral central incisor. The outer composite layer (i.e., facial enamel layer covering beyond the starburst bevel and all previously placed composite layers in their entirety) was placed and cured (Estelite Omega, Tokuyama) **(Fig 22)**.

Contouring, Finishing, and Polishing

Contouring was initiated by first establishing the appropriate outline form using a coarse disc, red flame-shaped finishing diamond, and blue points (Dialite, Brasseler USA; Savannah, GA) **(Figs 23a-23c)**. Finishing was then undertaken with a medium blue disc (FlexiDisc, Cosmedent; Chicago, IL) and pink diamond-impregnated points (Dialite), followed by a green striped diamond (6856L31.020, Brasseler) in an electric handpiece (NSK, Brasseler) on very slow speed to create tertiary anatomy or texture **(Figs 24a-24c)**. The final polishing phase was completed using a goat hair brush (Brasseler) with a chamois in the middle and composite polishing paste (Enamelize, Cosmedent) **(Figs 25 & 26)**.

The patient was dismissed and seen 5 business days later, at which time contouring and gradation of finishing and polishing was resumed (the author recommends that the patient be seen between 5 and 10 business days later so the tooth can rehydrate adequately). The definitive restoration demonstrates seamless integration and harmony with the surrounding dentition, as well as appropriate anatomy, texture, and sheen **(Figs 27a-30)**.

Figures 17a & 17b: (a) Preoperative smile view revealing the patient's unesthetic composite restoration on #9. (b) Retracted preoperative view with visible composite margin.

Figure 18: Using the selected shade of composite, place a higher chroma/dentin shade, translucency shade, and enamel shade in a "triangle" from thick to thin, and light cure.

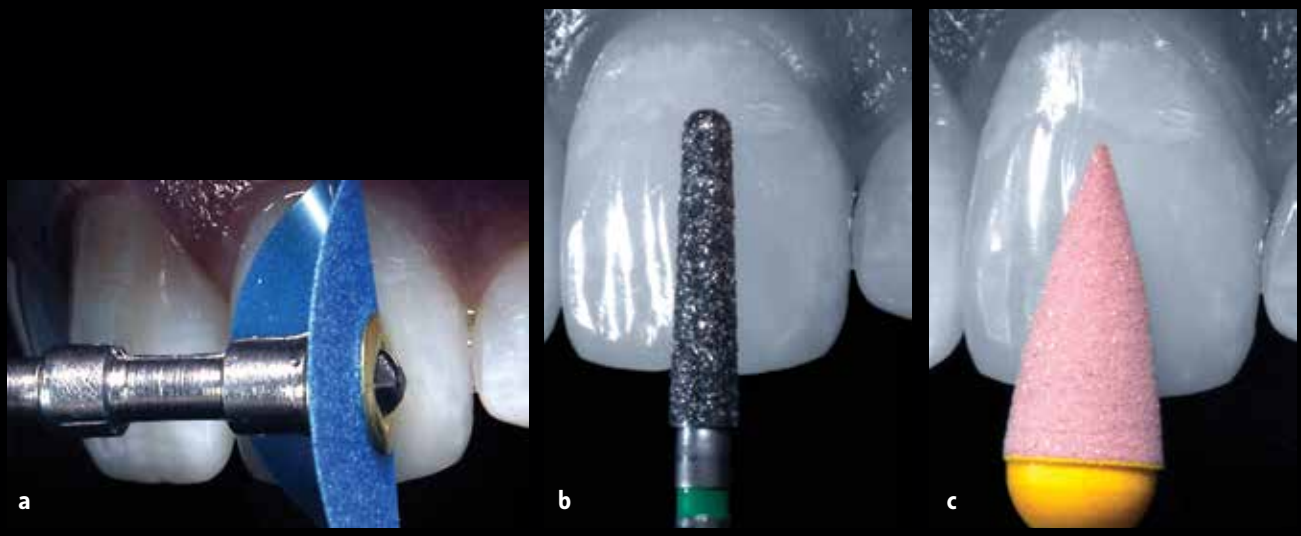
Figure 19: A ligated rubber dam was placed for ideal composite bonding.

Figure 20: A cut-back facially and incisally, with minimal starburst bevel, was all that was necessary due to the existing composite-to-tooth transition.

Figure 21: Routine etching, rinsing, and universal adhesive bonding protocols were performed.

Figure 22: The final enamel layer was applied to cover the bevel and extend up onto the gingival enamel.

Figures 23a-23c: (a) A coarse disc was used to contour the incisal edge and facial surface, and to establish the outline form of the tooth. (b) A red flame-shaped finishing diamond was used to finish the margins and develop the line angles, while (c) a coarse blue diamond-impregnated point was used for initial contouring.



Figures 24a-24c: (a) A blue (medium) aluminum oxide disc aided polishing, while (b) a coarse (green striped) diamond imparted tertiary anatomy. (c) A pink (medium) diamond-impregnated point was used for prepolishing.

Figure 25: A goat hair brush with chamois in the middle, along with polishing paste, was used to achieve the appropriate sheen for this patient.

Figure 26: View of the initial contouring, finishing, and polishing.

Figures 27a-27c: Views with various light sources showcasing the tertiary anatomy.

Figures 28a & 28b: Postoperative images of the well-integrated definitive restoration on #9, which was achieved without any biological sacrifice. (a) Retracted view. (b) Smile view.

Figures 29a & 29b: Two-year postoperative images. (a) Retracted view. (b) Smile view.

Summary

The ultimate goal of composite bonding is to achieve predictable and long-lasting restorative results in a minimally invasive way, without recurrent issues that warrant further removal of healthy tooth structure, or the use of more invasive and aggressive restorative techniques. The systematic approach described in this article—which is predicated on the clinician's ability to incorporate four clinical cornerstones into their direct composite protocol—will enable the creation of seamless, undetectable, and ultra-conservative additive restorations. By broadening their knowledge of and skill in executing starburst bevels, putty matrices, composite scaffolding and multilayering, and finishing and polishing, clinicians will be able to achieve composite restorations that mimic the beauty of natural tooth structure while enhancing its integrity in a biomimetic way.

Figure 30: Portrait of the happy patient.

Acknowledgment

The author thanks Zach Turner (Pearl River, NY) for creating the illustrations shown in Figures 2, 4a-7, 12-15, and 18.

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Dr. LeSage is an Accredited Fellow Member of the AACD and a Fellow member of AAED and AGD. The founder and director of the University of California, Los Angeles, (UCLA) Esthetic Continuum Levels I and II, he has maintained a private practice in Beverly Hills, California, for 31 years.

Disclosure: The author did not report any disclosures.


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