

The Aesthetic Composite Anterior Single Crown Restoration

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Achieving natural aesthetics by harmoniously matching the shape and color of a single anterior crown is perhaps one of the greatest challenges in restorative dentistry. The clinician must often rely on the artistic skills of a laboratory technician who has no direct access to the patient. The shade selection process is, therefore, impaired, and the final result may be a restoration which does not emulate the aesthetics of the adjacent natural dentition. The learning objective of this article is to present an innovative technique which utilizes the qualities of high strength laboratory processing in association with the application of light curing and freehand bonding of composite resins. This combination allows the clinician to predictably achieve aesthetic results with single anterior crowns. The direct, indirect, and indirect/direct restorations are discussed, and the laboratory and clinical procedures are reviewed.

The anterior segment of the dentition presents the greatest aesthetic restorative challenge, since the slightest smile or lip movement may reveal anatomic or color discrepancies. Although wide-span, anterior prosthetic restorations require a combination of functional and aesthetic expertise on the part of the restorative team — the clinician and the laboratory technician — it is the single tooth restoration that demands the greatest effort in emulating natural dentition (Figure 1). Numerous ceramometal and all-ceramic systems have been developed in recent years with multiple options for fabricating restorations that faithfully



Figure 1. Preoperative view. Maxillary left central incisor with acrylic provisional restoration. Matching the shape and color of a single anterior restoration presents a challenge.

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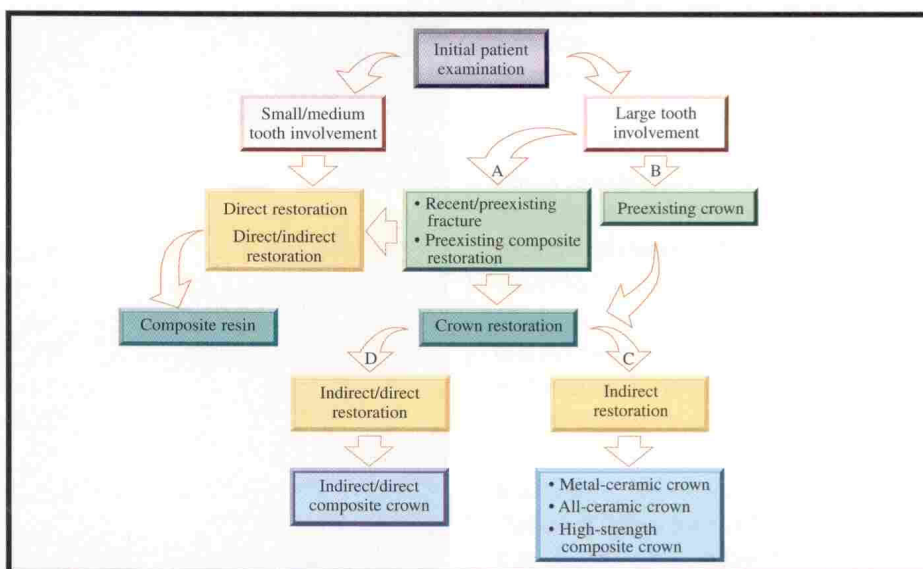


Figure 2. Diagram of restorative options.

replicate the natural dentition.¹⁻³ However, a ceramic restoration is only as good as the technician who constructs it, and perhaps only an exceptionally talented ceramist is able to render a single anterior restoration indistinguishable to the untrained eye.

Communicating the correct anatomy, translucency, opacity, color, and polychromatic variations to be created in a single anterior restoration can be a frustrating experience for a restorative dentist. The clinician and the laboratory technician generally do not share the same working facility, precluding direct access by the latter to the patient, and alternative methods must be developed. Schematic drawings, photographs, color slides, videotapes, digitized images, customized shade tabs, and detailed prescriptions are means by which the res-

Laboratory processed composites exhibit improvement in ... wear-resistance, color stability, and biocompatibility.

torative dentist conveys the perception of a natural-appearing tooth, in an effort to have it correctly interpreted by the technician.

Chairside composite restorations have emerged to provide the operator with greater control over the restorative process by sculpting the final restoration to the desired morphology and color. Due to remarkable improvements in composite resin formulations, a new technical and artistic level has been reached. The operator now can achieve polychromatic restorations that more closely resemble the intricate histologic and optical characteristics of dentin and enamel. A vast number of instructive publications can serve as guides in predictable aesthetic implementation of composite resins, whether addressing the simplest or the most complex cases.⁴⁻⁸ The choice between a fully direct⁹ or a direct/indirect (semi-direct)^{10,11} restorative approach with composite resins

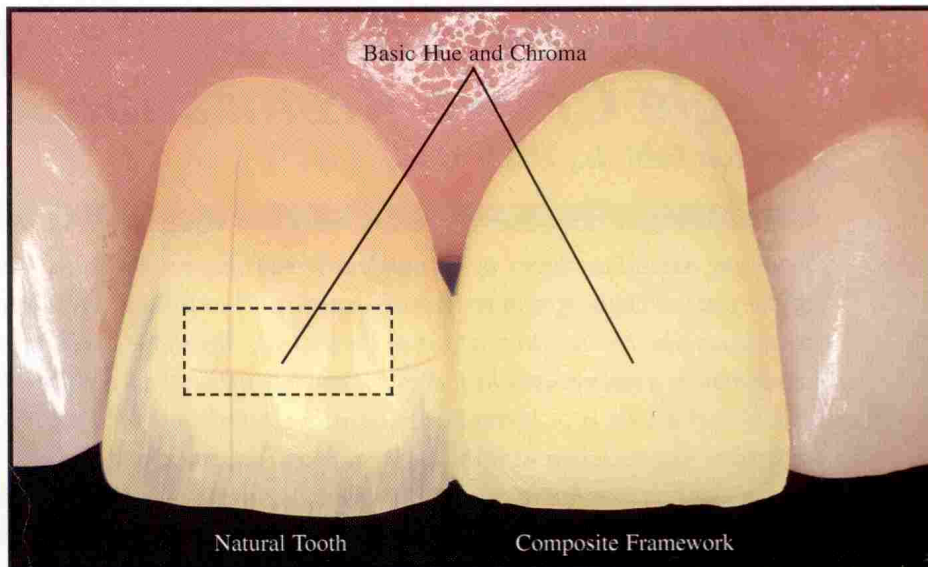


Figure 3. Shade of the composite framework is determined based on the hue and chroma of the middle third of the sound contralateral tooth.



Figure 4. Prepared maxillary left central incisor. A sufficiently reduced tooth preparation is imperative to achieve aesthetic success.

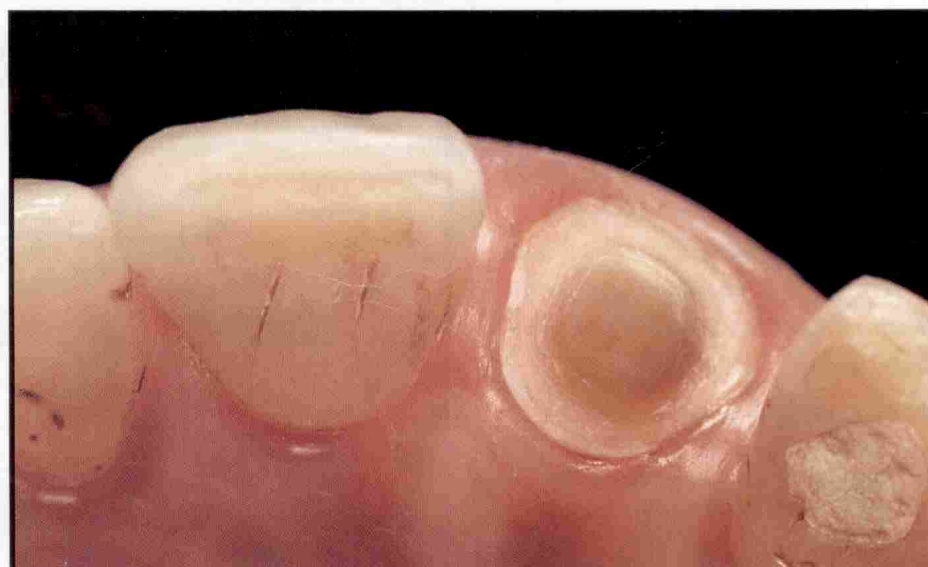


Figure 5. Occlusal view of the prepared incisor. Adequate labial reduction is imperative to create sufficient space for composite framework and composite build-up.

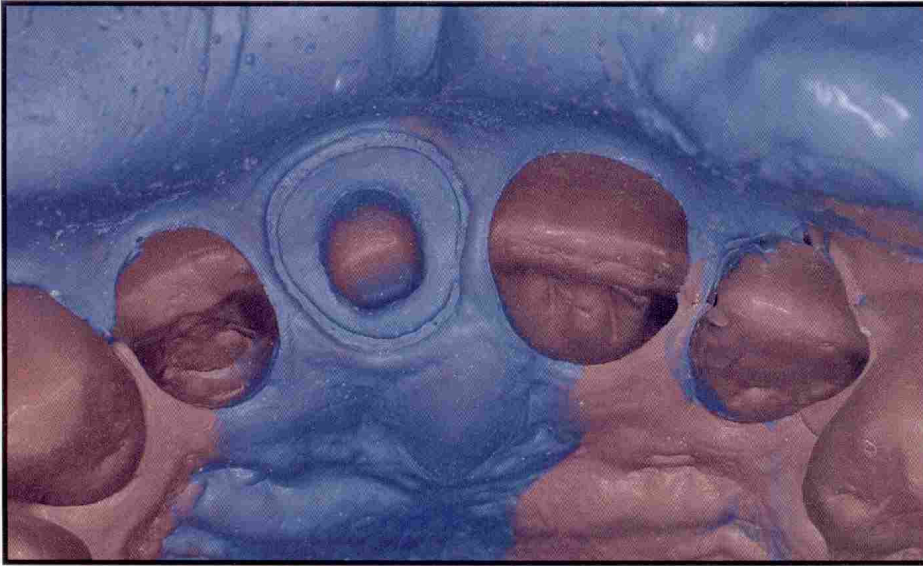


Figure 6. A polyvinylsiloxane impression material provides accurate marginal readings and allows several pours.

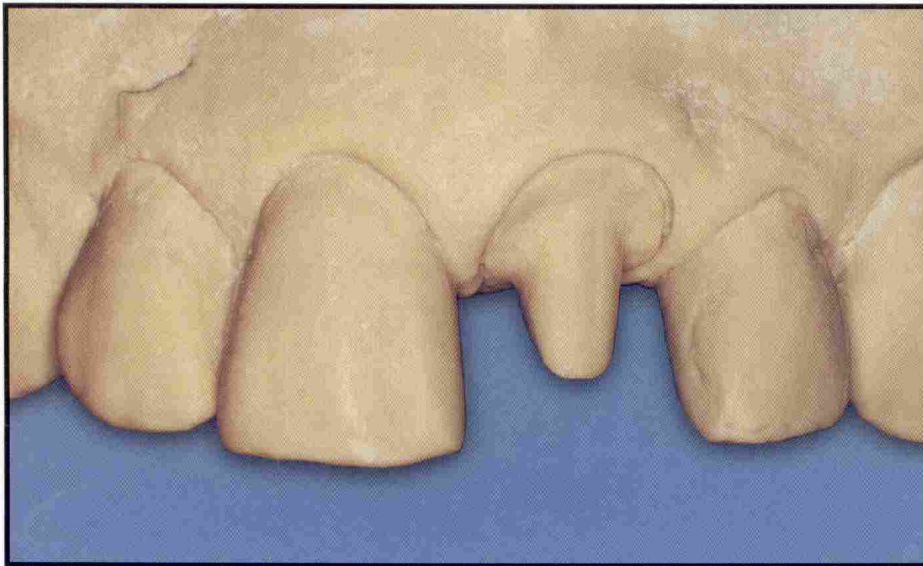


Figure 7. A master model is used for the framework build-up.

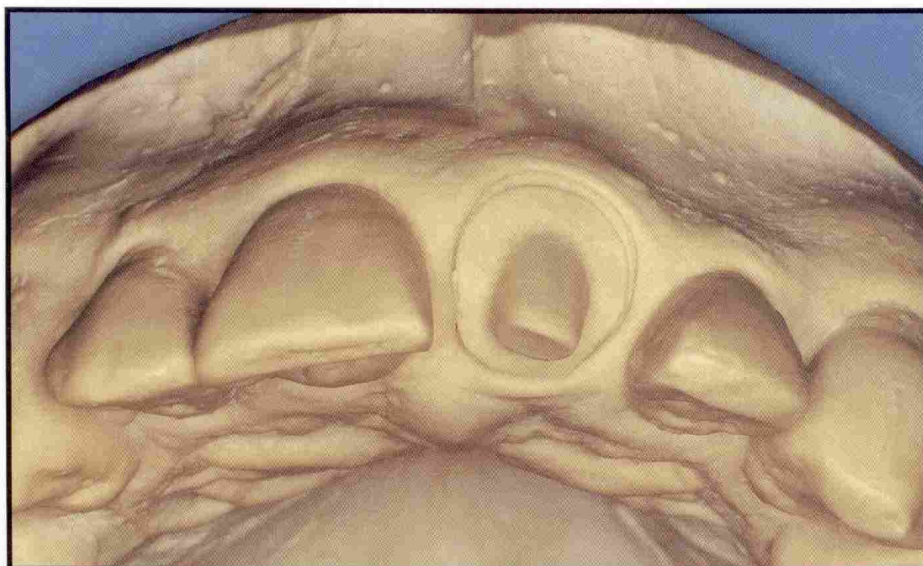


Figure 8. If the preparation margins are clearly visible, a solid working die may be used for the composite framework fabrication.

usually depends upon the appropriate indication for each specific case and the personal preference of the operator.

In selected cases, the responsibility for achieving aesthetic success in anterior restorations has shifted from the laboratory technician to the clinician using freehand bonding, who must be aware of all possible restorative options, direct or indirect, in order to provide state-of-the-art solutions. This article presents an innovative technique as an alternative to conventional ceramic anterior single crown restorations. It discusses the rationale for utilizing a laboratory fabricated, high strength, heat-tempered composite framework in association with the advantages of chair-side freehand bonding to create a functional and aesthetic composite crown restoration.



Flexural strengths of the most recent generation laboratory composite systems range between 120 and 160 megapascals (MPa).



DIRECT RESTORATIONS

Freehand bonding emerged in the early 1980s as a new philosophy in patient service and provided solutions for numerous aesthetic and functional challenges.^{12,13} Advancements in physical properties, shade availability, and adhesive technology allow the clinician to achieve more aesthetic and long-lasting restorations. New composites offer formulations with a wider range of translucencies, opacities, high strength, and optimal polishing characteristics, which allow the replication of subtle and marked intrinsic and extrinsic polychromatic variations present in natural tooth structure.¹⁴ Although improvement is still required, bond strengths to dentin have reached a level of clinical reliability that requires less tooth structure removal and achieves improved retention of the restorations.¹⁵⁻¹⁷ The application of direct composite restorations has advantages

and disadvantages that must be taken into consideration when selecting this treatment modality (Table 1).

INDIRECT RESTORATIONS

Ceramics and high strength composites are the most suitable selections for aesthetic anterior single crown restorations, due to the advantages inherent in the material and the laboratory fabrication process (Table 2). The new ceramometal and all-ceramic systems presently available offer important improvements in aesthetics, due primarily to improved light transmission, increased strength, enhanced wear-resistance, excellent fit, and improved biocompatibility.^{18,19} An added attribute is the highly polished margins that can reduce plaque accumulation and facilitate the maintenance of the surrounding soft tissue health.²⁰

Laboratory fabricated, highly-filled, high strength composites have been successfully utilized,²¹⁻²³ and their application includes inlays, onlays, veneer restorations, short-span bridges, and single crown restorations. When processed in the laboratory, these composites exhibit a greater conversion of the resin through increased polymerization. This conversion results in the improvement of the material's physical properties, such as wear-resistance, strength, elimination of shrinkage, enhanced color stability, and biocompatibility. Flexural strengths of the most recent generation laboratory composite systems range between 120 and 160 megapascals (MPa), with an elastic modulus of 8,500 MPa to 12,000 MPa.²⁴

INDIRECT/DIRECT RESTORATIONS: THE AESTHETIC ANTERIOR COMPOSITE CROWN

The indirect/direct composite crown restoration comprises advantages of both techniques (Table 3). It incorporates important benefits, resulting from laboratory processing (indirect stage), such as improved strength and wear-resistance, which prolong the life of the restoration; excellent marginal fit, which reduces microleakage and the risk of caries; highly polished margins, which contribute to low plaque accumulation



Figure 9. The framework is sculpted to full contour labially.

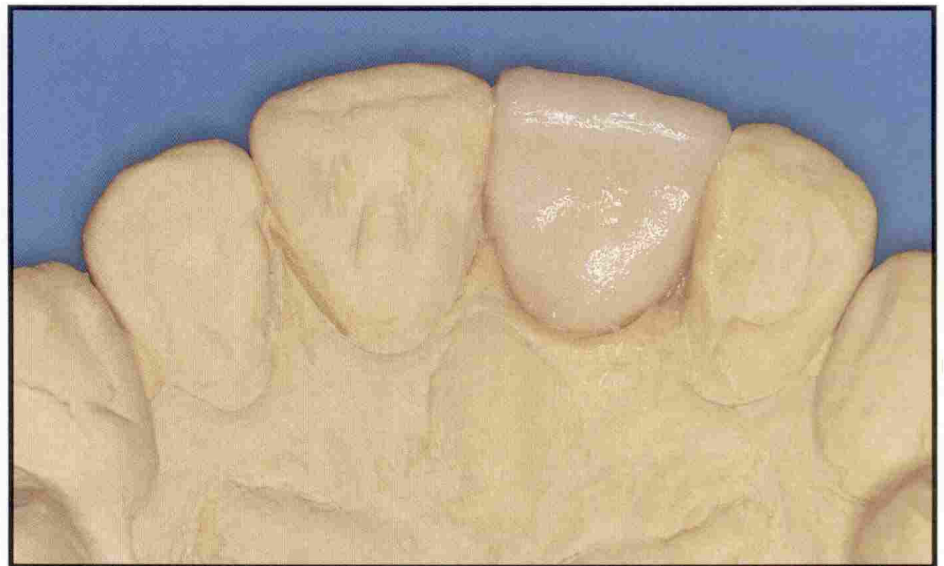


Figure 10. The framework is sculpted to full contour palatally.

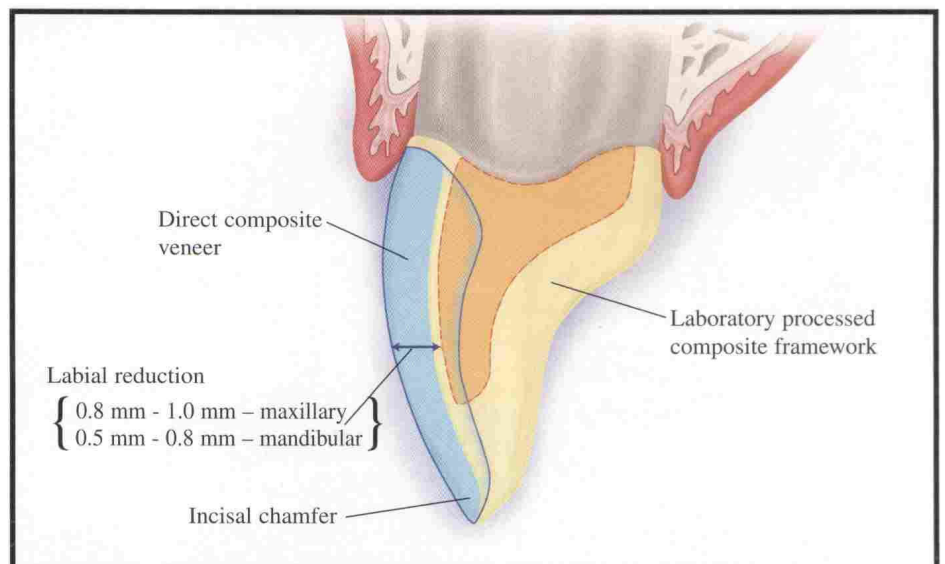


Figure 11. Composite framework design.

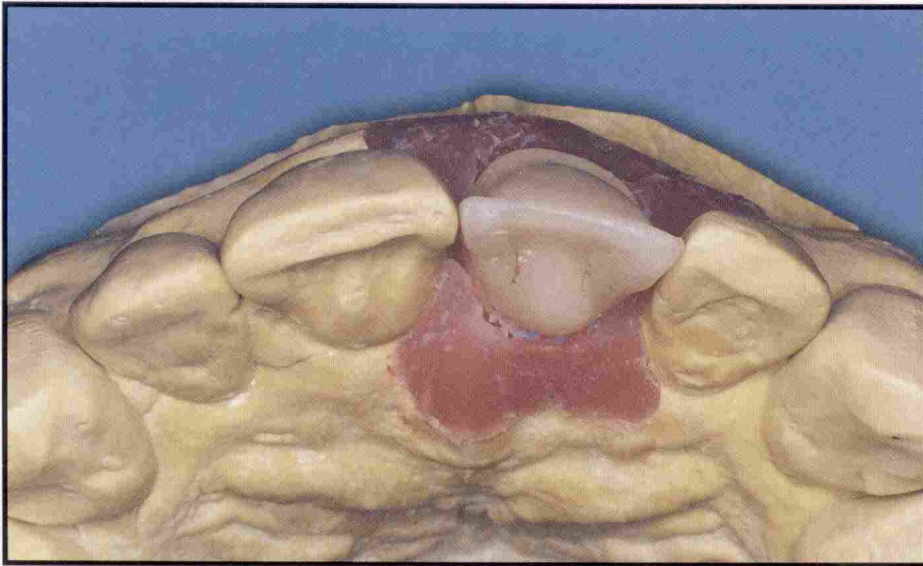


Figure 12. Sufficient labial space must be created to allow an aesthetic direct composite build-up.



Figure 13. The composite framework is positioned on the soft tissue model.

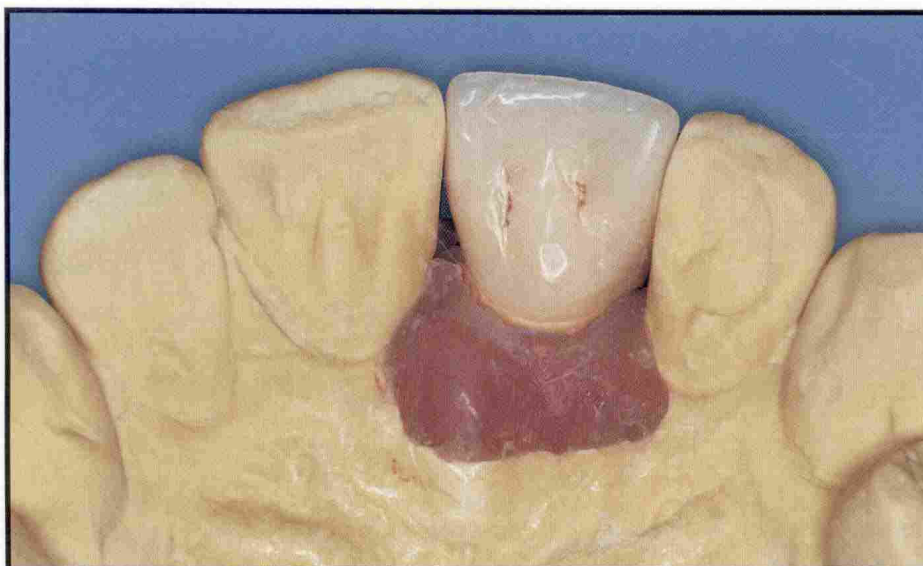


Figure 14. The accuracy of contours and angles are evaluated.

and superior gingival health. The free-hand bonding step (direct stage) allows the operator an almost absolute control over tooth shape and color.

Reproducing the subtleties of the primary (basic, geometric), secondary (lobes, developmental grooves, marginal ridges, cingulum), and tertiary (surface texturization) anatomies can be difficult when only a plaster model is used as a reference. The ability to cross-check contours and subtle morphologic variations chair-side throughout the layering process enhances the probability of reaching a more natural anatomic result.

Perhaps one of the most significant advantages of the indirect/direct composite crown restoration is the ability to more accurately reproduce the polychromatic nuances, translucencies, and opacities by using a sound natural tooth as a reference. To closely emulate the natural tooth, the clinician should maintain a broad comprehension of the concepts of hue, chroma, value, translucency, and opacity, and their relationship to the histologic characteristics of sound tooth structure, including the way the characteristics correlate with the optical and physical properties of composite resin materials. Since the indirect/direct composite crown restoration can be removed following direct composite application over the laboratory processed pattern, it can be heat-treated and further finished and polished prior to preparation for bonding and cementation. This allows an even greater enhancement of the physical and aesthetic properties.

RESTORATIVE OPTIONS

The selection of the treatment modality for a severely damaged single anterior tooth may present difficulties (Figure 2). The amount of tooth structure lost is determined at the initial examination; if a small to medium amount is lost, a direct composite restoration is usually the treatment of choice and can be accomplished in a single appointment. If the tooth structure involvement is extensive, two distinct restorative circumstances may result: A) a recent/preexisting tooth fracture or a defective composite restoration, and B) a preexisting defective crown restoration requiring replacement.

In circumstance A, the clinician may elect either a direct alternative, ie, a large composite reconstruction, a direct/indirect alternative, such as a direct/indirect composite veneer,¹¹ or an indirect alternative, ie, a single crown restoration. The number of patient visits, financial arrangements, occlusal factors, and the operator's personal preference and dexterity in freehand bonding will be the determining factors. If a pre-existing defective crown restoration requires replacement (circumstance B), or the restorative option for a large fracture or faulty composite restoration (circumstance A) is an indirect one, then a single anterior crown must be the treatment of choice. The clinician now has two alternatives: C) an indirect, fully laboratory processed restoration or D) an indirect/direct restoration.

... one advantage is the ability to more accurately reproduce the polychromatic nuances, translucencies, and opacities ...

The indirect, fully laboratory processed crown restoration presents numerous advantages, provided the restorative dentist has ways to achieve predictable aesthetic results through proper communication with the laboratory technician, particularly if the technician and the dentist share the same working facility. This allows an optimal setting, where the technician is able to select the shade using the patient's own natural teeth as a reference, under the clinician's supervision. However, this is an unusual opportunity, and other methods must be found. The indirect/direct composite crown may be a preference if the restorative dentist enjoys freehand bonding and is sufficiently knowledgeable about composite resin materials (ie, shade range, translucencies, and opacities) and their physical properties to confidently reproduce the subtleties of shape and color of natural dentition.



Figure 15. The composite framework is tried in.



Figure 16. Accuracy of fit, contours, and shade is evaluated.



Figure 17. Occlusal view. The amount of labial reduction of the framework is evaluated intraorally.

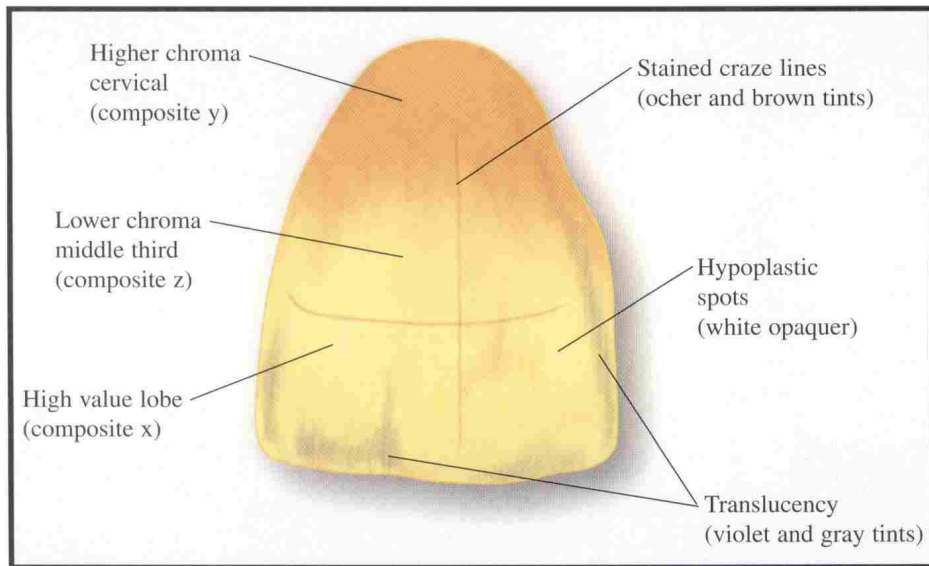


Figure 18. A schematic drawing is used as a guide throughout the composite build-up procedure. The polychromatic characteristics and the restorative materials should be outlined.

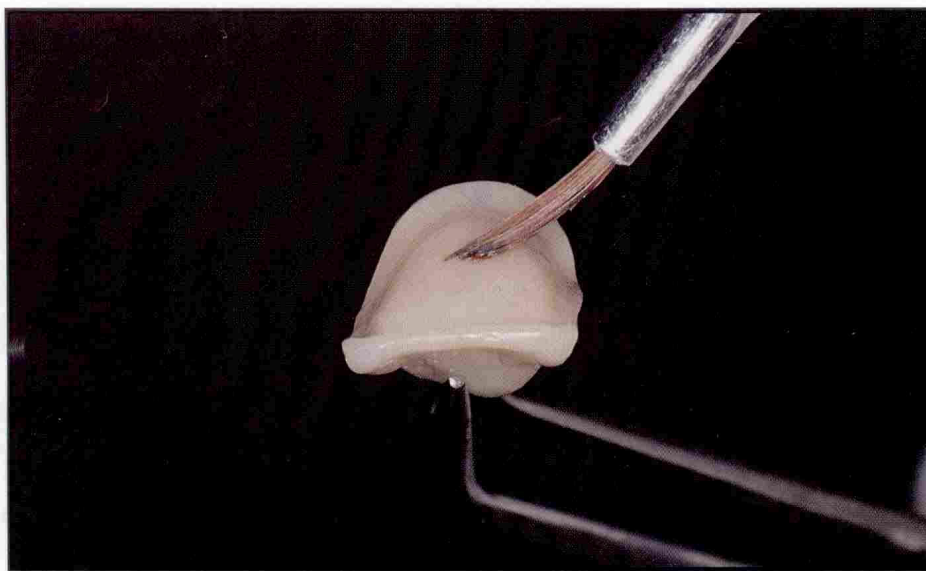


Figure 19. The framework is prepared for direct bonding.

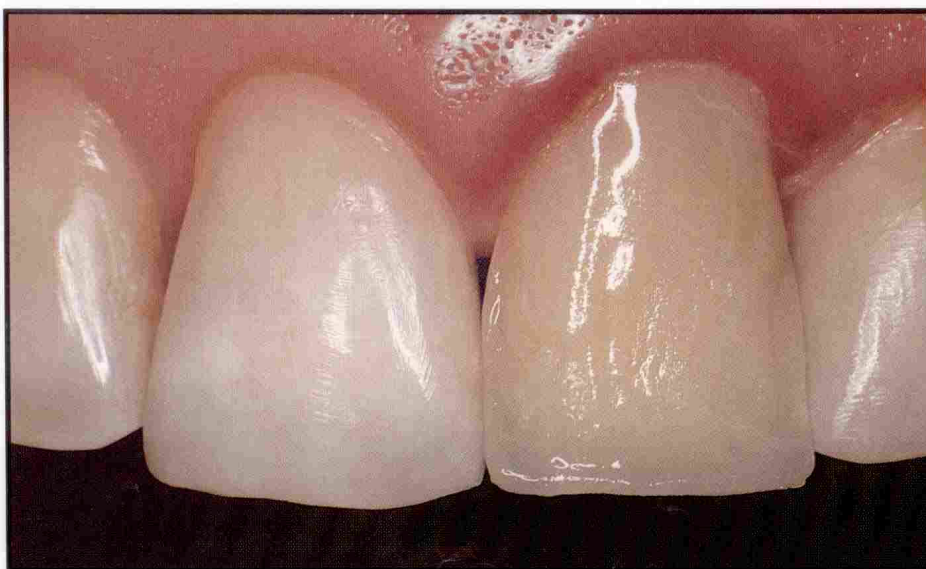


Figure 20. A higher chroma composite is used as the cervical increment. The maxillary left central incisor was direct-veneered with composites.

THE RESTORATIVE PROCEDURE

The technique described may be used with any high strength laboratory composite resin system. The author has selected a particular system (Concept, Ivoclar/Williams, Amherst, NY) that has gained increased acceptance among restorative dentists and patients, due to its excellent aesthetics and physical properties,²⁵ particularly in the posterior area. The microfill is 76% inorganic, highly filled by weight, with a greater inorganic loading than is possible with direct microfilled composites. Since there is no prepolymerization, the uniformly-sized submicron filler is evenly dispersed. The dispersion results in improved properties (since dissimilar particles can cause adverse effects, such as fractures). When processed under heat

Occlusal factors, and the operator's personal preference and dexterity in freehand bonding will be the determining factors.

(120°C), a higher degree of resin polymerization ensues, while the pressure (80 psi, 6 bahr) reduces porosity, and the overall physical properties of the composite material are greatly enhanced. The restorative steps for the indirect/direct composite crown restoration are as follows:

- First clinical stage.
- Laboratory stage.
- Second clinical stage.

First Clinical Stage

1. Initial Evaluation

Initial evaluation involves assessment of gingival asymmetries, localized gingival recessions, and excessive gingival display, which should be surgically corrected prior to the actual restorative phase.¹⁹ The endodontic profile of the tooth to be restored must also be evaluated.

2. Shade Selection

The shade for the laboratory processed composite framework must be determined and selected prior to dehydration of the natural tooth that is used for color reference. Using a proper shade selection technique,⁵ the basic hue and chroma of the middle third of the sound tooth is determined (Figure 3) and charted. The middle third is selected due to lower chroma (less saturated hue) and higher value (lighter hue) than the cervical third. Since it is easier to elevate the chroma and lower the value than to achieve the opposite, this facilitates any required chroma and value modifications during the actual direct composite build-up at the second clinical stage.

3. Tooth Preparation

A sufficient reduction in tooth preparation is imperative in order to achieve

Initial evaluation involves assessment of gingival asymmetries, localized gingival recessions, and excessive gingival display ...

aesthetic success (Figures 4 and 5). The labial reduction must allow enough space for the composite framework and the overlaying directly placed composite resin, thereby avoiding overcontouring. If severe discoloration is present, butt margins should be placed at least 0.5 mm to 0.8 mm intrasulcularly. When discoloration is not a concern, the labial margins should be placed at the gingival crest level or slightly subgingivally.

4. Impression

The impression should be made using an elastomeric material of sufficient tear strength, such as a polyvinylsiloxane (eg, Extrude, Kerr, Glendora, CA; Express, 3M, St. Paul, MN), since it permits several pourings without tearing or distorting the impression (Figure 6).

5. Provisionalization

To present excellent marginal fit, the provisional restoration should be carefully adjusted to proper contour, and the desired tooth form of the final

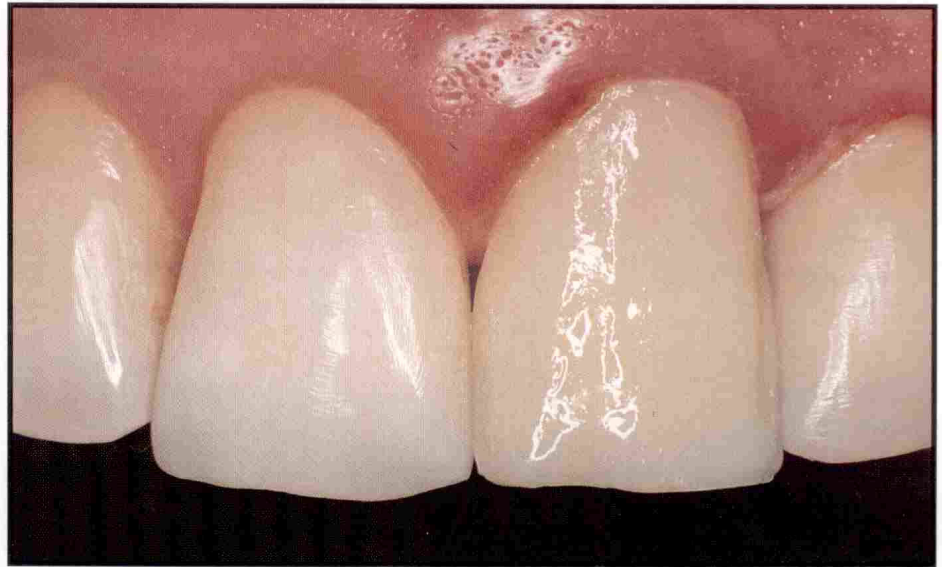


Figure 21. The dominant hue and chroma are achieved with the sequential application of other increments.



Figure 22. Intrinsic characterizations are reproduced with the aid of tints and opaques.



Figure 23. A final increment of composite is applied, and the labial aspect of the restoration is brought to full contour.



Figure 24. The composite crown is removed from the prepared tooth, further finished, polished, and heat-tempered.



Figure 25. Palatal view of the restoration.

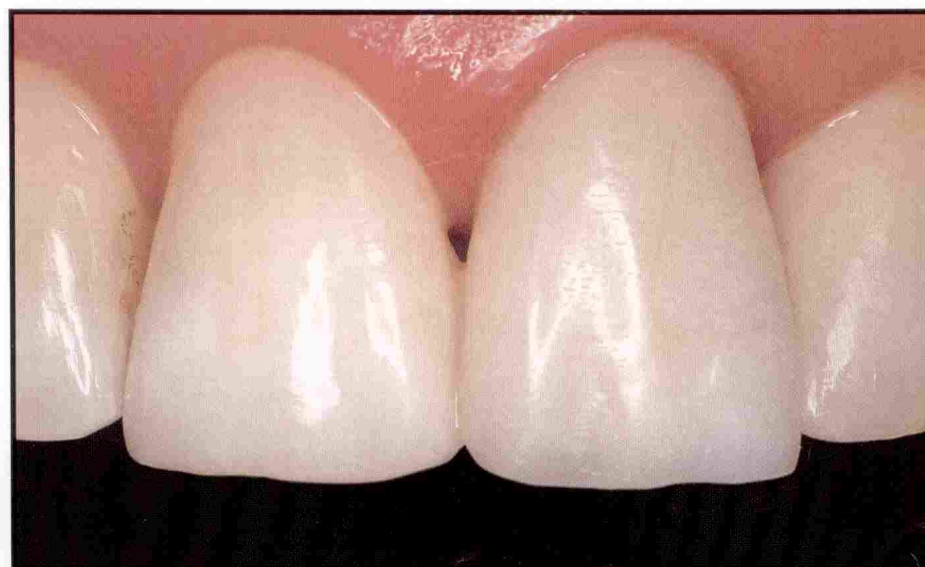


Figure 26. Highly polished margins and optimum precision of fit result in excellent health of the surrounding soft tissue. Facial close-up view.

restoration must be achieved at this stage. An alginate impression of the cemented provisional restoration is made, and a study model is obtained to be used as a guide by the technician to replicate its exact shape, position, and alignment for fabrication of the definitive restoration. If the desired form of the provisional restoration has not been achieved through intraoral adjustments, a diagnostic wax-up should be performed on the study model. This step will minimize the need for chairside shape modifications of the composite framework. An impression of the opposing arch and occlusal record should be obtained as well.

Laboratory Stage

1. Working Models

Two master models should be poured with extra-hard stone. One is used for

The labial reduction must allow enough space for the composite framework and the overlaying directly placed composite resin ...

the framework build-up and the other for adjusting contacts and contours. If the margins are clearly accessible, a solid model is used and no removable die is necessary at this time (Figures 7 and 8). The second model is trimmed, and a gingival simulation material (eg, Moulage, Kerr, Glendora, CA) is applied in order to serve as a reference for a correct restoration / soft tissue relationship through the establishment of proper emergence angles.

A single die is fabricated of epoxy material (eg, Epoxy-Die, Ivoclar/Williams, Amherst, NY) and is used to finish the margins. The epoxy material has excellent edge strength and precise reproduction of impression details, and the accuracy of the composite framework fit is greatly improved.

2. Fabrication of Composite Framework

Several excellent laboratory systems are available for building the composite framework. Each system requires its

own processing/polymerization technique and may involve heat-and-pressure or light curing of the resin.^{24,26} In the system used, the framework is built up in increments of the preselected shade to full anatomic contour, including the labial aspect of the restoration, according to the manufacturer's instructions (Figures 9 and 10). It is then heat-and-pressure processed in a polymerization apparatus (Ivomat IP3, Ivoclar/Williams, Ivoclar, Amherst, NY), removed from the stone model, and finished. Accuracy of marginal fit of the framework is achieved through sequential finishing with proper rotary instruments on the die, made from the epoxy material. The framework should be completely finished and polished prior to the labial reduction.

The labial reduction follows the same preparation guidelines as those for porcelain or composite veneer restorations.²⁷ To avoid random reduction of the labial aspect of the framework, depth cutters (eg, Laminate Veneer System, Brasseler, Savannah, GA) may be used. Sufficient labial space must be created through correct preparation to allow an aesthetic incremental appositioning of the restorative composite resins, yet avoiding overcontouring the restoration (Figures 11 and 12). A minimum reduction of 0.8 mm to 1.0 mm for the maxilla and 0.5 mm to 0.8 mm for the mandible is recommended. An even, precise framework veneer preparation can be accomplished with the use of long, tapered, coarse diamond burs (eg, Laminate Veneer System and/or #0850-014, #6856L-016, Brasseler, Savannah, GA) under high speed, and finished under low speed using the same rotary instruments.

The cervical chamfer should be placed within the framework, following the free gingival margin from papilla tip to papilla tip and approximately 0.5 mm from the tooth preparation finish line. Interproximal chamfer finish lines should be placed up to the middle of the interproximal contact areas of the adjacent teeth, without breaking contact. In order to minimize the potential of chipping the composite resin veneer (that will be directly built up at the second clinical stage) during excursive movements of the mandible or mastication, a



Figure 27. Facial/lateral close-up view.



Figure 28. Postoperative view of the maxillary incisors. Note the color and form integration of the maxillary left central incisor.



Figure 29. Postoperative view of the anterior dentition at natural smile. Note the harmony between the restoration and the adjacent dentition in the maxilla and the mandible.

Table 1
Direct Composite Restorations

Advantages

- Single appointment.
- Conservative tooth preparation.
- Greater control by the operator over tooth shape and color.
- Patient anticipation in the planning and restorative process.
- Easy repair.
- Postoperative shape and color refinement may be performed at second appointment, if required.
- Lower fees may apply.

Disadvantages

- Extensive anterior restorations may require more than one appointment.
- Technique sensitivity. The operator must be totally familiar with materials and techniques.
- Smoking and dietary habits can produce staining.
- Occlusal forces and mastication can cause chipping of incisal edges.
- Highly polished, ledge-free subgingival margins are difficult to attain.
- Surface texture and secondary anatomy are lost with time.
- Polymerization shrinkage and noneffective bonding agent application can lead to microleakage and secondary caries.

Table 2
Indirect Restoration Ceramic and High-Strength Composites

Advantages

- Improved physical properties.
- Increased strength.
- Excellent marginal fit.
- Highly polished margins — superior periodontal health.
- Durable surface texture and secondary anatomy (especially ceramics).
- Can be bonded with minimum cement film thickness, decreased polymerization shrinkage, and reduced microleakage.
- Better color stability.
- Improved light transmission (ceramics).

Disadvantages

- At least two appointments are necessary.
- Painstaking shade communication with laboratory.
- Tooth preparation is more invasive than for direct restorations.
- Operator has little or no control over tooth shape and color; they are laboratory dependent.
- Postoperative refinement of shape and color are more difficult to perform at second appointment, if necessary.
- Usually higher fees apply.
- Intraoral repair is more technique-sensitive (ceramic).

Table 3
Indirect/Direct Restoration: The Aesthetic Anterior Composite Crown Restoration

Advantages

- Operator has greater control over final aesthetics.
- Shade communication with laboratory is easier.
- Shape and color postoperative refinement can be performed at second appointment, if necessary.
- Improved physical properties from heat-pressured lab processing plus heat-tempering after direct composite veneering.
- Good resistance to occlusal forces and mastication.
- Excellent marginal fit can be achieved.
- Highly polished margins, superior periodontal health.
- Surface texture and secondary anatomy are more durable than direct composites.
- Can be bonded with minimum cement film thickness, decreased polymerization shrinkage, and reduced microleakage.
- Improved color stability.

Disadvantages

- Technique sensitivity. The operator must be proficient in freehand bonding and be knowledgeable about composite materials and color.
- At least two appointments are necessary.
- Tooth preparation is more invasive than for direct restorations.
- Usually higher fees apply.
- Overall aesthetics may not be as natural as that of a crown made by a skilled ceramist.
- May take a while to reach the peak of the learning curve.

chamfer finish line must be confined along the incisal edge of the framework. The composite framework is positioned on the soft tissue model with the artificial gingiva, evaluated, and its contours and angles properly adjusted (Figures 13 and 14).

Second Clinical Stage

1. Try-In of Framework

Once the composite framework is returned from the laboratory, it must be tried in and evaluated for accuracy of fit, contours, and shade (Figures 15 through 17).

2. Selection of Restorative Composite Resins for Direct Veneering

The selection of shade and corresponding restorative composite resin materials must be performed prior to dehydration of the anterior natural dentition, which results in an elevated value.⁵ A contralateral sound tooth should be used as a reference for shade selection. It should be compartmentalized in thirds by horizontal and vertical imaginary lines, to facilitate a correct and more detailed assessment of hue, chroma, value, translucency, and opacity of each area. The restorative resins with the closest matching characteristics should be placed in small increments over the corresponding areas, polymerized, wetted, and their matching properties evaluated.

The use of opaques and tints should be carefully considered if intrinsic characterization is to be replicated. Prior to their actual application, they should be carefully tried and evaluated in order to avoid shade and opacity mismatches and prevent overemphasizing the desired effects. A schematic drawing, displaying the polychromatic characteristics of the tooth used for color reference and the composite resins selected, is a great adjunct in guiding the clinician throughout the direct bonding procedure (Figure 18).

3. Preparation of Framework for Direct Composite Veneering

To maximize adhesion, the entire labial preparation should be first sandblasted (eg, Microetcher II or Miniblaster, Danville Engineering, San Ramon, CA) and then cleaned with a 32% to 38% phosphoric acid gel. A light-cured

methacrylate solvent-primer (Special-bond II, Ivoclar/Vivadent, Amherst, NY) should be applied to enhance bondability (Figure 19).²⁸ If a hybrid laboratory system (eg, Herculite XRV-LAB, Kerr, Glendora, CA; Tetric-LAB, Ivoclar/Vivadent, Amherst, NY) or a "ceramic polymer" (eg, Artglass, Heraeus Kulzer, Irvine, CA; BelleGlass HP, belle de st. claire, Orange, CA; Targis/Vectris, Ivoclar/Williams, Amherst, NY; Conquest, Jeneric Pentron, Wallingford, CT) is selected, the bonding surface of the framework must be sandblasted, cleaned and acidified with a 32% to 38% phosphoric acid gel, and silanated.²⁹

4. Direct Composite Build-Up

Isolation can usually be accomplished with cheek and lip retractors, cotton rolls, and gauze. Depending on the system used for framework fabrication, a bonding agent is applied to the labial preparation, light cured, and the framework is gently seated into position. Incremental layering of the previously selected composite resins is performed according to the diagram, drawn from the natural tooth used for color reference (Figures 20 through 23). Each increment should be artistically sculpted with instruments and brushes, and individually cured to allow enhanced control over the desired anatomy. Once the composite build-up is completed, and the final shape of the restoration is achieved, finishing and polishing are performed in the conventional manner. The composite crown restoration can then be removed from the prepared tooth and further finished and polished, if required (Figure 24).

5. Heat Treatment of the Composite Crown

The directly veneered composite must be additionally light cured for 2 minutes, and the composite crown must then be placed into a heat-and-pressure tempering oven (eg, Ivomat, Ivoclar/Williams, Amherst, NY) at 120°C for 10 to 15 minutes in order to promote complete resin polymerization and improved physical properties.³⁰⁻³³ Since not every clinician has a heat-and-pressure tempering oven available, the author suggests placing the composite veneer restorations in boiling water for 10 minutes, set at the highest temperature.

6. Cementation of the Composite Crown

The inner surfaces of the composite crown restoration and the bonding aspects of the tooth should be sandblasted to optimize bond strengths³⁴ and prepared for indirect bonding. The total-etch technique, followed by a latest generation adhesive system should be used. A dual-cure resin cement should be selected to guarantee maximum polymerization, and the manufacturer's recommendations for preparation of tooth and restoration for bonding should be strictly followed (Figures 25 through 29).

CONCLUSION

Numerous materials and techniques are currently available to restore a single anterior tooth to its original function, shape, and color. Each presents some advantages and disadvantages that have to be taken into consideration when selecting the treatment modality. Due to its physical properties and optical and chromoscopic characteristics, ceramic reproduces the natural tooth structure most closely. However, it requires the acute perception and skilled hands of a ceramist to predictably achieve such physics-related phenomena on a clinical basis.

Direct composite restorations have been and most probably will continue to be the restorative option for a considerable number of anterior cases, since the final result is highly dependent on the artistic ability of the experienced clinician. As with anything else in dentistry, freehand bonding requires persistent training and the desire to reproduce the intricacies of natural dentition through keen observation, proficient knowledge, and the use of one's own hands.

The aesthetic anterior composite crown restoration is neither the only nor the best alternative to solving aesthetic concerns that involve the restoration of a single anterior tooth. It is merely another option in treatment planning that combines the advantages of direct and indirect techniques. Depending on the case indication and the clinician's freehand bonding aptitude, it can be a valuable option, resulting in patient satisfaction and growth of the practice.

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