

COMPOSITE RESIN LAYERING AND PLACEMENT TECHNIQUES: CASE PRESENTATION AND SCIENTIFIC EVALUATION

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Composite resin technology has evolved, providing clinicians with the ability to deliver more natural-looking restorations for their dental patients. The evolution of layering techniques and internal staining procedures has further improved composite resins' potential for optimal results. This article discusses difficulties associated with traditional composite layering and staining, and it presents in vitro research that supports a novel layering approach. Specifically, the cut-back, etch, bond, and layer technique (CEBL) is introduced as an alternative to freehand layering.

Learning Objectives:

This article presents current concepts for composite resin layering and bonding technology. Upon reading this article, the reader should:

- Understand the clinical protocol for resin layering and bonding.
- Recognize the scientific advantages associated with composite layering with the CEBL technique.

Key Words: composite, layering, bonding, cut-back, etch

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The continued evolution of composite layering techniques has significantly enhanced clinicians' delivery of predictable and natural-looking resin restorations. Dentists today are embracing the concept of composite stratification, and most contemporary composite systems include an assortment of opacities designed for use in advanced layering techniques. While the delivery of layered composite restorations remains a viable aesthetic option, many clinicians struggle with the technique sensitivity of placing several shades within a direct composite restoration.¹

Techniques for internally stratified, direct resin restorations are highly dependent on the clinician's skill, and care must be taken to ensure that the exact thickness and shape of each layer is accurately predicted. While the artistic capabilities of each clinician vary, appropriate restorative techniques can be learned. Pioneers in the field of operative dentistry have long advocated freehand placement of various opacous, body, and translucent materials onto the air-inhibited layer of the previously cured increment.^{2,3} It is the presence of this 3- μ m to 5- μ m layer of unpolymerized resin on the surface that provides the organic coupling sites for the additional increments. While layering composites in this fashion is optimal, the complexities of pre-determining the exact thickness, placement, and shape of each layer and opacity complicate freehand layering for some clinicians. In the event that the previous layer was found to be too thick, clinicians have two options. The first is to cut-back the anatomically incorrect layer to the appropriate shape and contour with a rotary instrument and continue with layering. The second option is to remove the entire restoration and begin again. The former is a more practical approach as it saves valuable chairtime and effort.

Another practical consideration that would warrant cutting back of a polymerized layer of composite prior to additional layering is the concept of building an entire direct veneer to full contour in a single shade, and then deliberately cutting back the incisal third to create space



Figure 1A. Preoperative right buccal view demonstrating short, dark lateral incisors. **1B.** Left buccal view of unaesthetic lateral incisors. The patient desired a more even smile line.

for internal anatomy (eg, mammelons) and receptacles to receive internal tints. This technique is used routinely in dental laboratories, where a single shade of ceramic ingot is pressed to full contour. The incisal third is then cut-back, and specialized tints and various shades of translucent enamel feldspathic porcelains are applied and fired. By adapting this same concept to direct composite veneers, clinicians may find the technique of reduction from full contour easier and less time-consuming than additive layering to accomplish the same goals.

One concern with this technique, however, is the quality of the bond between layers of cured composite once the air-inhibited layer is removed following the cut-back procedure. Intraoral repair of existing composite resin restorations has proven to be unreliable without extraordinary measures. Reportedly, this is due to the lack of chemical union of the layers.^{4,5} It has been reported, however, that in freshly cured composite resin—even after the air-inhibited, resin-rich layer is removed—radicals remain available for reaction in the body of the cured composite.⁶ The stability of these radicals is temperature- and formula-dependent, but it is reasonable to presume that in the time frame of a direct resin clinical procedure, they would be available for affecting a chemical union between a cut-back layer and freshly placed composite resin.



Figure 2. The lateral incisors were initially built to full contour with a body shade of composite resin to confirm final anatomic contour prior to cut-back.

This article presents an in vitro analysis that supports the practice of cutting back, etching, bonding, and continued layering (CEBL); it also demonstrates a clinical protocol consistent with these findings.

Case Presentation

A 26-year-old female patient presented with short, dark, lateral incisors and the desire to eliminate her “buck” teeth (Figure 1). The patient desired a more even smile line, which would involve lengthening the clinically short crowns of teeth #7(12) and #10(22). Since the lateral incisors were unrestored healthy teeth, aesthetic restoration with a minimally invasive approach was desirable. Noting the preoperative presence of maverick tints, incisal edge translucency, and varying degrees of opacity in the surrounding dentition, two polychromatic, internally stained, stratified direct veneers were prescribed for teeth #7 and #10.

Freehand layering with multiple shades and opacities of directly placed composite was considered. This approach would be complicated, however, by the need to preoperatively determine the correct length and contour of these teeth and to eliminate the potential for undesirable, nonworking, excursive interferences. The novel CEBL approach of building the entire veneer of a polymerized base shade to full contour and evaluat-

ing the occlusion and aesthetic form prior to the placement of internal tints and translucency was initiated.

The lateral incisors were built out of a body shade of microhybrid composite (ie, Esthet•X, Dentsply Caulk, Milford, DE) to full contour utilizing a freehand technique (Figure 2). Contemporary resin systems such as Premise (Kerr/Sybron, Orange, CA) or Filtek Supreme (3M Espe, St. Paul, MN) represented similar restorative material options. By building the tooth to full contour, the clinician could visualize the final contours in comparison to the adjacent teeth and be assured that the final restoration would be of appropriate length in relation to the aesthetic objectives and limitations of the patient’s occlusion. The initial buildup was light cured. The incisal third of the fully contoured, polymerized restoration was then cut-back using a diamond bur to create anatomic developmental lobes and dentin mammelons. Since the final facial and incisal contours had been approved prior to cut-back, the complications sometimes associated with failing to leave enough space for the subsequent layering of internal tints and the overlying translucent enamel layer were avoided (Figure 3).

The polymerized buildup was re-etched using a phosphoric acid gel etchant to provide a clean, active surface for bonding the final buildup (Figure 4). A light-curable, self-priming adhesive (ie, Prime & Bond NT, Dentsply Caulk, Milford, DE) was applied and polymerized for 20 seconds (Figure 5). Internal characterization was then applied using soft brown and yellow tints (ie, Effect Color, Heraeus Kulzer, Armonk, NY) to match the maverick stains present in the surrounding natural dentition (Figure 6). The tints were then polymerized. The final translucent incisal layer was subsequently applied over the cut-back lobes and the incisal tints (Figure 7). The restoration was then light cured, finished, and polished (Figure 8).

Evaluation of Shear Bond Strength of Layered Composite

The following in vitro evaluation was performed to deter-

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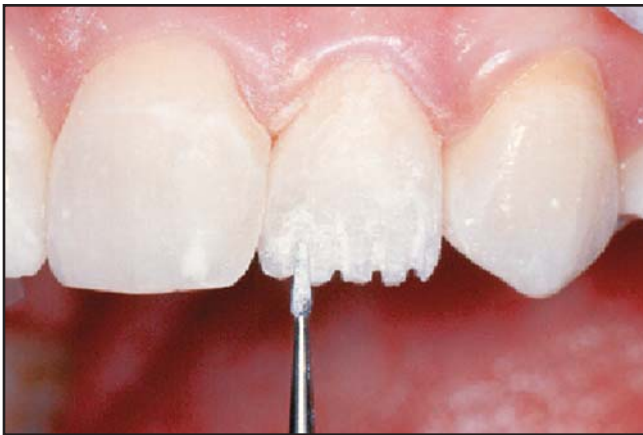


Figure 3. An incisal cut-back was performed to create dentin lobes and the framework for incisal translucency.



Figure 4. The incisor was isolated with a metal strip and a phosphoric acid gel etchant was applied to acidify and cleanse the prepared surfaces.

mine the bond strengths of composites placed using a simulated layering approach. The shear bond strengths (SBS) for layering two different composite materials were established. Determining SBS is a widely used screening test to evaluate adhesive materials and techniques using a variety of materials and substrates including enamel, dentin, metals, and other restorative materials. While bond testing alone is not completely discriminating among materials and techniques, the numerical values and the pattern of bond failures can be helpful in screening. Higher bond strengths and failure patterns of a cohesive nature would suggest that the CEBL technique would be durable clinically.

Materials and Methods

A total of 48 cavities (6 mm × 4 mm) were prepared in aluminum molds. A base layer of composite resin was then placed and flattened. The samples were light cured for 40 seconds from all sides. Four experimental groups represented different conditions prior to simulated layering (Table 1).

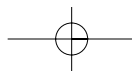
The positive control (ie, the intact air-inhibited layer) represents the best possible condition for layering. The negative control removes this layer and bonds to an untreated ground surface. The CEBL groups included the cut-back, followed by the removal of debris with a phosphoric acid conditioner, application of a



Figure 5. A light cured primer/adhesive agent was applied and subsequently polymerized.



Figure 6. Internal characterizations were added to the buildup in order to provide the appearance of natural dentition that matched the surrounding shade nuances.



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Figure 7. A final translucent shade was then layered and sculpted using a composite instrument.



Figure 8A. Postoperative buccal view of the restored lateral incisor. **8B.** Left lateral incisor after buildup. Note the harmonious integration with the surrounding dentition.

dentin/enamel adhesive, and then application of an uncured composite resin. The CoJet (3M Espe, St. Paul, MN) group was added as reference since excellent bond strengths have been reported with this system.⁵

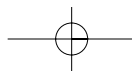
The following composite resins and adhesives were used in this investigation:

- Esthet•X composite resin (Dentsply Caulk, Milford, DE)
 - Substrate — Shade A2
 - Veneer — Enamel GE
 - Adhesive — Prime & Bond NT
- Venus composite resin (Heraeus Kulzer)
 - Substrate — Shade A2
 - Veneer — Enamel T1
 - Adhesive — Comfort Bond

Following specimen preparation, one half of the assemblies in each group were stored in water at 37°C for 24 hours; the remaining specimens were prepared for immediate testing. The assemblies were then loaded to failure in an Instron 1123 test frame at a cross-head speed of 5 mm/min. Mean SBS was calculated in Megapascals (MPa) and fracture sites were evaluated to determine if they were adhesive, ie, at the interface between the ground layer and the added composite, or cohesive with the fracture occurring in the substrate composite. Both ANOVA and Tukey's post-hoc test were used for data analysis.

Table 1

<i>Experimental Groups Prepared for Simulated Layering</i>		
Group (12 Specimens Each)	Base Layer Treatment	Application of Layering Resin
1. Positive Control	Air-inhibited layer left intact	Gelatin capsule loaded with layering resin, applied, and light cured
2. Negative Control no additional treatment	Ground with 320 grit;	Gelatin capsule loaded with layering resin, applied, and light cured
3. Etch and Adhesive (CEBL Technique)	Ground with 320 grit; etched, adhered, light cured	Gelatin capsule loaded with layering resin, applied, and light cured
4. Co-Jet (3M Espe, St. Paul, MN)	Ground with 320 grit; sandblasted with Co-Jet sand, silanated, adhered, light cured	Gelatin capsule loaded with layering resin, applied, and light cured



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Table 2

<i>Mean Shear Bond Strength for Esthet•X</i>		
Surface	Debond Immediate	Debond 24 Hours
Ground 320 grit	13.6 ± 2.1	21.9 ± 3.4
Air-inhibited layer	19.7 ± 1.8	35.0 ± 3.5
Etch and Adhesive (CEBL Technique)	19.0 ± 1.8	34.2 ± 4.1
CoJet	19.4 ± 2.4	33.9 ± 3.8

Table 3

<i>Mean Shear Bond Strength for Venus</i>		
Surface	Debond Immediate	Debond 24 Hours
Ground 320 grit	13.6 ± 3.1	29.3 ± 6.7
Air-inhibited layer	16.9 ± 1.6	33.2 ± 4.7
Etch and Adhesive (CEBL Technique)	17.1 ± 2.4	32.8 ± 3.1
CoJet	16.6 ± 2.1	31.5 ± 2.3

Table 4

<i>Failure Rates for the Resin Materials</i>				
Surface	Esthet•X Immediate	Esthet•X 24 Hours	Venus Immediate	Venus 24 hours
Ground 320 grit	All adhesive	All adhesive	All adhesive	All adhesive
Air-inhibited layer	All cohesive	All cohesive	All cohesive	All cohesive
Etch and Adhesive (CEBL Technique)	All cohesive	All cohesive	All cohesive	All cohesive
CoJet	All cohesive	All cohesive	All cohesive	All cohesive

Results

The mean SBS were tabulated for both Esthet•X and Venus. In the former (Table 2), ground values were significantly lower ($p < 0.05$) than in the air-inhibited layer, CEBL, or CoJet groups. In the latter (Table 3), no statistical difference in bond strength was observed for any group. The failure patterns for each group were also calculated (Table 4).

Discussion

Similar bond strengths and fracture patterns were evident using the CEBL technique, even when the air-inhibited layer was removed. Even more important than the numerical values, however, the fracture patterns evident with the CEBL technique were identical to those of composite resin layered to the unaltered, air-inhibited layer. This suggests that the chemical union is similar to that achieved with the air-inhibited layer intact, and a restoration layer using the CEBL method should have the durability of a conventionally layered restoration.

Conclusion

Even after removing the air-inhibited layer, the CEBL technique generated similar bond strengths and fracture patterns as those for bonding to the air-inhibited layer. After long-term water storage, the CEBL technique was successful for bonding to Esthet•X but not to Venus. The results of this study support an immediate cutback and rebonding placement technique for layering these two multishaded composite resin systems.

References

- Fortin D, Vargas MA. The spectrum of composites: New techniques and materials. *J Am Dent Assoc* 2000;131(Suppl):26S-30S.
- Fahl N Jr. Optimizing the esthetics of Class IV restorations with composite resins. *J Can Dent Assoc* 1997;63(2):108-115.
- Jackson RD. Understanding the characteristics of naturally shaded composite resins. *Pract Proced Aesthet Dent* 2003;15(8):577-585.
- Kupiec KA, Barkmeier WW. Laboratory evaluation of surface treatments for composite repair. *Oper Dent* 1996;21(2):59-62.
- Denehy G, Bouschlicher M, Vargas M. Intraoral repair of cosmetic restorations. *Dent Clin North Am* 1998;42(4):719-737.
- Burtscher P. Stability of radicals in cured composite materials. *Dent Mater* 1993;9(4):218-221.

CONTINUING EDUCATION (CE) EXERCISE No. X



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

The 10 multiple-choice questions for this Continuing Education (CE) exercise are based on the article "Composite resin layering and placement techniques: Case presentation and scientific evaluation," by Jeff T. Blank, DMD, and Mark Latta, DDS, MS. This article is on pages 000-000.

1. The best reason for layering modern composite resin systems in anterior restorations is:

- To generate maximum strength of the resin mass.
- To enhance the delivery of predictable, natural looking restorations.
- To best replicate the shape of adjacent teeth.
- To promote adhesion to tooth structure.

2. Bonding between layers of composite is most often facilitated by:

- Mechanical retention between the resin layers.
- Chemical bonding between the new resin layer and the air-inhibited layer of the previously cured increment.
- An adhesive agent placed on the resin surface.
- Acid etching the cured composite.

3. The chief reason to cut-back a cured layer of composite is to:

- Provide mechanical retention for bonding.
- To strengthen the bond between the resin layers.
- To remove the air-inhibited layer.
- To better control the thickness of the layered resin shade.

4. The laboratory process that is imitated in layering an anterior Class IV restoration using the CEBL technique is:

- Waxing a restoration to full contour.
- Placing surface stain on a porcelain crown.
- Cutting back a cast ceramic ingot and layering tints and shaded porcelains for characterization.
- Using diamond pastes for polishing the porcelain surface.

5. The most obvious clinical example concerning the quality of the bond between layers of composite placed after a cut-back is:

- The unreliability of intraoral repair of older composite restorations.
- Microleakage and stain between composite layers.
- Lack of retention of layers in posterior composite restorations.
- Color change of the composite placed in layers.

6. The proposed mechanism for the CEBL technique is:

- Mechanical retention between the resin layers.
- Polymerization shrinkage compressing the new resin layer to the old resin layer.
- Use of the air-inhibited layer for bonding.
- Remaining free radicals are available for reaction in freshly cured composite even once the air-inhibited layer is removed.

7. Which of the following are the sequence and steps for the CEBL technique?

- Place adhesive/layer composite/cure composite.
- Cut-back cured layer/place adhesive/layer composite/cure composite.
- Cut-back cured layer/etch and rinse/layer composite/cure composite.
- Cut-back cured layer/etch and rinse/place adhesive/layer composite/cure composite.

8. In the laboratory study, the negative control was:

- The air-inhibited layer surface.
- The ground surface with no treatment.
- The Co-Jet-treated surface.
- The CEBL-treated surface.

9. Compared to the bond values achieved with the air-inhibited layer:

- The Co-Jet and CEBL technique generated similar bond values.
- The negative control generated similar bond values.
- The negative control generated better bond values.
- No difference was seen with any group.

10. The pattern of fracture failures observed for the CEBL and air-inhibited groups:

- Were both cohesive supporting the use of the CEBL technique for layering.
- Were cohesive for the air-inhibited group and adhesive for CEBL, indicating CEBL does not work.
- Were the same as the adhesive group.
- Do not contribute to the interpretation of the study.