LAYERING AND CURING TECHNIQUES FOR CLASS III RESTORATIONS: A TWO-YEAR CASE REPORT

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The direct resin buildup of a Class III restoration based on contemporary layering and curing techniques allows clinicians to provide conservative treatment and a virtually imperceptible blend with adjacent tooth structures. This presentation describes a new approach to the Class III buildup. The importance of restoring enamel and dentin as two different substrates is also stressed. In this context, the selection of a microhybrid composite resin system able to reproduce the optical and mechanical properties of the natural dentition can help to achieve these goals.

Learning Objectives:

This article discusses a new approach to the Class III buildup. Upon reading this article, the reader should:

- Identify the importance of restoring enamel and dentin as two different substrates.
- Understand the direct resin procedures for Class III restorations.

Key Words: adhesive, composite resin, Class III, layering, curing

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Resin-bonded composite (RBC) has undergone continuing development of physical and mechanical properties in the last decade.[1,2] As a consequence, the clinical indications for anterior RBC restorations have expanded (Table 1). At the same time, patients' expectations for imperceptible dentistry is increasing; the popularity of bleaching procedures has helped drive the demand for aesthetic treatment.[3] Once teeth are bleached, patients can discover the minimal alteration of tooth shape and position that was previously masked by dark color and often become motivated to further enhance their smiles.

Dentists are required to strictly re-create the anatomy, shade, and texture of natural teeth. Previous RBC systems were based on the use of a single enamel and dentin shade that poorly reproduced the optical properties of natural teeth.[4] More recently, the vitality and depth of a restoration has been achieved through the use of RBC systems based on *natural* layering techniques.[5] These systems use dentin masses that reproduce the fluorescence of natural dentin and enamel to mimic the opalescence and translucence of natural enamel.

In order to achieve aesthetic anterior RBC restorations, clinicians have to choose an appropriate layering technique and select the correct shades to build up the teeth of young, adult, and geriatric patients. The integration of the restoration with the adjacent teeth

Figure 1. Preoperative facial view demonstrates the marginal discoloration present on teeth #7(12), through #10(22).

Figure 2. Facial view showing the anterior teeth following the completion of tooth bleaching.

Table 1.

Clinical Indications for Anterior Direct Resin Composite Restorations

Composite Types	Clinical Indications
Microfills	Enamel replacement in Class III, IV, and V restorations Minimal correction of tooth form and localized discoloration
Hybrids	Class V restorations Dentin buildup in Class III and IV restorations
Microhybrids	Class III, IV, and V restorations Composite resin veneers Correction of tooth form and discoloration
Nanofills	Class III, IV, and V restorations Composite resin veneers Correction of tooth form and discoloration

Table 2.

Recommended Photocuring Time(s) and Intensities for Enamel and Dentin Buildup

Buildup	Composite Shade (Vit-l-Escence)	Polymerization Technique	Intensity (mW/cm²)	Time(s)
Proximal and Palatal Enamel	PF	Pulse	200 + 300	3 + 40
Dentin	A3.5, A3, A2, A1	Progressive Curing	300	40
Facial Enamel	PF, TM, TF, T1	Pulse	200 + 600	3 + 30

Figure 3. Facial view of tooth #7 and #8(11) after placement of the rubber dam and removal of the existing RBC restorations.

Figure 4. Etching was performed using 35% phosphoric acid (ie, Ultra Etch, Ultradent Products, South Jordan, UT).

and surrounding soft tissues is paramount to obtaining satisfactory results.[6] Furthermore, a curing method should be adopted to reduce stress at cavosurface margins and thus add to the long-term clinical success of the RBC restoration.

The potential of a pulse-curing technique in reducing stress has been reported[7,8] and its clinical application has been recently described.[9,10] Based on this premise, clinicians can place direct RBCs that should challenge ceramic restorations in terms of longevity and aesthetics.[10]

Case Presentation

A 40-year-old male patient presented with unaesthetic Class III restorations in the maxillary anterior region (Figure 1). The patient reported that the teeth were restored one year earlier with RBC that underwent a progressive marginal discoloration. A treatment plan that involved tooth whitening and subsequent replacement of the Class III restorations was discussed and accepted by the patient.

Alginate impressions of the maxillary and mandibular arches were made, poured with dental stone, and the resultant casts were trimmed and prepared for a custom stent. A light-cured resin blockout material (ie, Triad Gel, Dentsply Preventive Care, York, PA) was placed on the facial surface, extending 1 mm from the gingival, mesial, and distal margins. Trays were fabricated using a heat/vacuum tray-forming machine and

Figure 5. Facial view of tooth preparations after the adhesive agent was applied.

Figure 6. The mesiodistal proximal surfaces of tooth #8 were built up using a PF-shaded increment of microhybrid resin.

were then properly trimmed to fit each model before delivery to the patient. The patient was instructed on proper self-care and use. Tooth whitening was accomplished using a 10% carbamide peroxide gel for 2 weeks in each arch (Figure 2).

The restorations were delayed 2 weeks to better match the adjacent tooth structure and avoid oxygen inhibition of adhesive and composite resins. Shade selection was performed before any restorative procedures were commenced, thus avoiding tooth dehydration and creating a more ideal shade match. Texture was analyzed, as were the spatial references of the teeth to be restored.

A rubber dam was placed, and dental floss was used to complete isolation and expose the cavosurface gingival margins. The existing RBC restorations were completely removed, taking care to preserve as much tooth structure as possible. Cavity preparation was completed, rounding sharp angles with #2 and #4 burs and placing a 1-mm bevel on the facial surface with a carbide flame bur (Figure 3). A bevel was not placed on the palatal surface. The cavity preparation was disinfected using a 2% chlorhexidine antibacterial solution. A teflon strip was placed to avoid etching of the adjacent tooth structure and was then used as an interproximal matrix. Teeth #7(12) and #8(11) were etched for 15 seconds using 35% phosphoric acid (Figure 4); the etchant was removed, and the cavity was water sprayed for 30 seconds, being careful to maintain a moist surface. A fifth-generation adhesive system (eg, PQ1, Ultradent Products, South Jordan, UT; One-Step, Bisco, Schaumburg, IL) was placed in the preparation, gently air thinned (Figure 5), and polymerized for 20 seconds at 600 mW/cm^2 on the facial and palatal aspects using a curing light.

Figure 7. The palatal surface of tooth #8 was built up on the mesiodistal preparations.

In order to avoid microcrack formation on the facial and palatal surfaces, the authors used a previously described technique. This approach was based on the combination of a pulse-curing and progressive-curing technique, plus a composite placement technique with wedge-shaped increments.[9,10] This technique was adopted in an attempt to reduce polymerization shrinkage, thereby decreasing stress at the enamel composite interface.

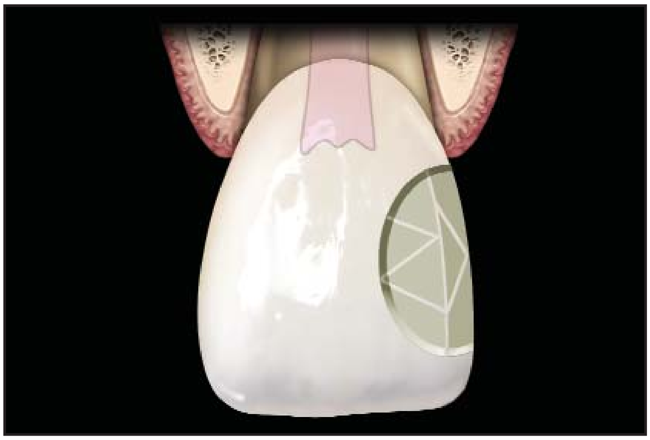

Figure 8. Illustration of the wedge-shaped increments used in the direct buildup of the proximal and palatal enamel surfaces.

Figure 10. The restorations on teeth #7 and #8 were completed, and existing RBC restorations on teeth #9(21) and #10 were removed.

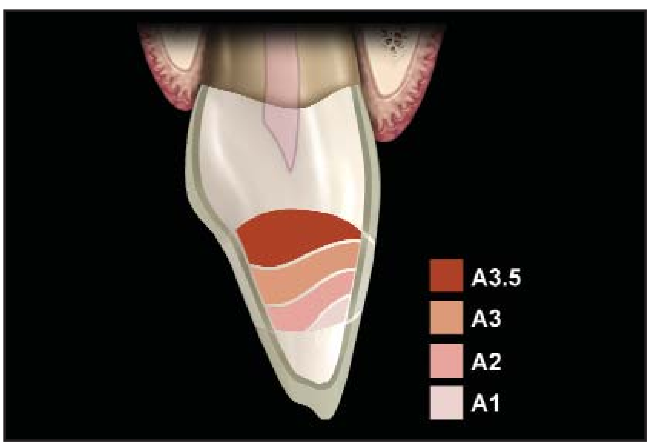

Figure 9. Schematic representation of dentin composite resin stratified layering technique.

A microhybrid RBC (ie, Vit-l-escence, Ultradent Products, South Jordan, UT) was selected as the material of choice to restore these teeth. Using a natural layering technique,[5] however, other microhybrid composites (eg, Esthet•X, Dentsply Caulk, Milford, DE; Point 4, Kerr/Sybron, Orange, CA; Amelogen, Ultradent Products, South Jordan, UT) could have been utilized as well. Stratification was initiated with a 1-mm to 1.5-mm triangular-shaped, gingivoincisal placed layers of resin (pearl frost [PF] shade) to reconstruct the proximal surface. This uncured composite was condensed and sculpted against the teflon strip and each increment was pulse-cured for 3 seconds at 200 mW/cm^2 to avoid microcrack formation. Final polymerization of the composite PF proximal wall was subsequently completed at 300 mW/cm^2 for 40 seconds (Figure 6). Placement of wedge-shaped increments of composite resin is of paramount importance because it helped in decreasing the configuration (C)-factor (ie, the ratio between bonded and unbonded surfaces).[11]

Stratification of the palatal wall was initiated using 1-mm to 1.5-mm wedge-shaped increments of RBC, which was cured utilizing the same protocol as the proximal layer (Figures 7 and 8). The dentin segment of the restoration was filled using a higher chroma in the most cervical portion of the preparation (ie, A3.5, A3) and lower chroma (ie, A2, A1) in the middle third as demonstrated in the stratified layering technique (Figure 9).[1,12] Each dentin increment was cured using a progressive-curing technique (ie, 40 seconds at 300 mW/cm^2) instead of a conventional continuous irradiation mode (ie, 20 seconds at 600 mW/cm^2).[9,10] An enamel layer of RBC was then applied to the final contour on the facial surface (Figure 10). This final layer was pulse-cured for 3 seconds at 200 mW/cm^2. A period of 3 minutes was observed to allow for stress relief prior to final polymerization at a higher intensity (30 seconds at 600 mW/cm^2) (Table 2).

Composite layering of tooth #7 was subsequently performed. Once these two RBC restorations were completed, the teflon strip was removed, and dental floss was placed in the cervical area of teeth #9(21) and #10(22). The existing RBC restorations were removed, and the cavities were prepared in the same manner as for teeth #7 and #8 (Figure 10). A new teflon strip was placed over teeth #7 and #8, and bonding and restorative procedures were also completed for teeth #9 and #10 (Figure 11). In the next appointment, a similar restoration was delivered for tooth #6(13).

The rubber dam was removed, occlusion was checked, and each restoration was polished (Figure 12). At the 2-year recall, the same restorations evidenced the original anatomy and shade (Figure 13), and no marginal discoloration or enamel microcracks were detected.

Figure 11. Enamel and dentin layering of the RBC was completed using the identical direct resin bonding procedure.

Discussion

Class III restorations are widely considered as the most durable RBC restorations. This is attributed to several factors: 1) they are usually placed in low stress-bearing areas; 2) they have a favorable C-factor; and 3) the cavity is usually surrounded by enamel. Although earlier generations of adhesive systems and RBCs were used, Class III RBC restorations functioned longer even after a declining aesthetic profile. With the introduction of modern adhesive systems based on the total-etch technique, the clinical performance of Class III restorations has improved. A common occurrence, however, is a mismatched Class III restoration. Marginal discoloration and recurrent decay contribute to this phenomenon.

Figure 12. Postoperative facial view of definitive direct resin restorations evidences the polished, aesthetic results achieved.

This case report presents a new technique to overcome these issues and introduces an easier and faster method to build up Class III restorations. The technique may be considered the treatment of choice for teeth with three-surface "through and through" Class III restorations.

Polymerization shrinkage can be influenced by different factors: C-factor, modulus of resin elasticity, composite placement technique, and the rate of polymerization. Clinicians have two methods to control RBC polymerization shrinkage: the rate of polymerization and the composite placement technique.[9,10]

As handling properties of microhybrid RBCs have improved, sculpting of composite is easier with clinicians incorporating both the correct shade and anatomy into the definitive restoration when layering the composite resin (Figure 9).[10] The composite buildup technique presented provides reduced time for finishing and polishing procedures, avoids color mismatches previously encountered when removing excess, and by building up

Figure 13. At 2 years, the restorations continue to evidence natural aesthetics and seamless integration with the adjacent tooth structures.

the proximal surface first, enhancement of spacial references is created to better restore the remaining portion of the restoration.[10] Moreover, in order to decrease the C-factor, thin layers of wedge-shaped composite increments were strategically placed to a single surface or to fewer bonded surfaces without contacting opposing cavity walls.[13]

Increased interest has been reported with regard to contemporary light-curing techniques as a possible method for controlling stress.[7,8,14,15] Resin composite goes from a pre-gel state (early setting) to a post-gel state (final setting) during polymerization. During the early setting, polymerization shrinkage is compensated by flow of composite particles in the direction of cavity walls; once the gel point is achieved, flow cannot occur because of the increased stiffness of RBC.

The soft-start polymerization concept was introduced in the early 1990s and considered a valid option to reduce polymerization shrinkage.[14] Composite chemistry has changed in the last decade, however, and current composite systems are considered more photosensitive than previous generations.[8,16] This means that an initial intensity lower than the one provided with conventional soft-start polymerization may be required to delay the gel point and reduce stress value to a higher degree. Moreover, photosensitivity varies greatly between current RBCs. This phenomenon can explain the contradictory results obtained by many differing studies when using the soft-start polymerization and dissimilar composite systems.[14,15,17,18]

Notable is the fact that the cavosurface margins have their highest stress at the facial enamel margins. They are exposed to the highest intensity. It is important to adopt a curing technique that reduces stress development at this critical location, thus avoiding the formation of microcracks.

Studies have reported that enamel microcrack formation can be reduced with a pulse-curing technique.[7,8] The bonding interface may remain intact, but microcracks may develop just outside the cavosurface margins due to the stress of polymerization shrinkage. Therefore, the use of such a curing technique may be particularly relevant when enamel is not supported by the underlying dentin as in the case report presented above (ie, tooth #8). This may be a very common situation in Class III RBC restorations due to more rapid development of decay in dentin than enamel. Furthermore, lower light intensity and longer curing time have improved marginal adaptation while maintaining the excellent physical properties of composite.[19,20] The progressive-curing technique used to polymerize dentinal increments may be critical in transmitting lower stress at the cavosurface margins (Table 2).

Conversely, there is an increasing trend in realizing a fast curing strategy by reducing curing time and increasing light intensity. The introduction of high-intensity light-emitting diode lights has hampered efforts to employ a low-intensity strategy. Light-emitting diode curing lights have a spectral pattern that matches the absorption peak of camphoroquinone much better than do traditional quartz-tungsten halogen lights.[21,22] The result is that the physical properties of RBCs may be improved, but the gel point is further anticipated — with the resulting RBCs lacking sufficient time to flow and release internal stress.

Ideally, RBC manufacturers should inform clinicians of the total energy required to reach the gel point. Light-curing unit manufacturers should include a curing mode to allow clinicians adequate control of both time and intensity, thus reducing the initial energy emitted (delay the gel point).

Conclusion

The clinical case presented is considered a common situation in the everyday clinical practice. Improvements in adhesive and RBC systems have fostered the development of aesthetic dentistry. Clinicians should keep in mind an appropriate placement technique to help improve their skill when placing Class III restorations. Particular attention should be focused on the photopolymerization process and understanding its potential and limitations. Only in this way, can the restorative clinicians provide both functional and aesthetic care to their patients.

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CONTINUING EDUCATION (CE) EXERCISE NO. X

X
CONTINUING EDUCATION

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 "Layering and curing techniques for Class III restorations: A two-year case report," by Simone Deliperi, DDS, David N. Bardwell, DMD, MS, M. Debora Congiu, DDS, Gerard Kugel, DMD, MS. This article is on pages 000-000.

1. In the article, the resin material used as a replacement for dentin and enamel was a:
a. Flowable and microhybrid composite.
b. Flowable composite.
c. Microhybrid composite.
d. Flowable and packable composite.

2. The following curing technique used to polymerize the enamel facial portion of the restoration was:
a. A pulse-curing technique.
b. A soft-start polymerization.
c. A conventional continuous irradiation.
d. None of the above.

3. The following composite placement technique used to build up the composite restoration was a(n):
a. Horizontal technique.
b. Combination of an oblique and horizontal technique.
c. Bulk technique.
d. Oblique technique with wedge-shaped composite resin increments.

4. The following curing technique used to polymerize the dentin portion of the restoration was a:
a. Conventional continuous irradiation.
b. Pulse-curing technique.
c. Progressive curing technique.
d. Soft-start polymerization.

5. In this article, the following type of light-curing system used to polymerize the restorations was:
a. Plasma.
b. Quartz-tungsten halogen.
c. Laser.
d. LED.

6. The recommended time required to restore teeth after completing tooth whitening is:
a. 48 hours.
b. 48 hours if the material is applied only on the facial surface.
c. 2 to 3 weeks.
d. More than 3 weeks.

7. The main factors influencing the polymerization shrinkage include the:
a. C-factor.
b. Stratification technique.
c. Curing technique.
d. All of the above.

8. The main reason to build up the proximal surface first is to:
a. Increase the bond strength of the composite resin to the tooth structure.
b. Enhance spacial references and gain better control of stress from polymerization shrinkage.
c. Help reduce microleakage.
d. All of the above.

9. The correct thickness of each layer of resin-based composite to be polymerized in the incremental technique is:
a. Less than 2 mm.
b. 2 mm to 3 mm.
c. 3 mm to 4 mm.
d. More than 4 mm.

10. What is the clinical indication for the use of microhybrid composite in the anterior region?
a. Class III and Class V.
b. Class IV.
c. Composite veneer.
d. All of the above.