editorial commentary

Preheating Composite Resin: A Clinical Perspective

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Clinical success with direct restorations is the result of the correct use and high performance of adhesive systems, composite resins, and light-curing systems. In the former, improvements have been noted with total-etch adhesive systems; longitudinal clinical studies have reported the enhanced performance of three- and two-step total-etch systems over previous generations.[1-4] Their increased efficacy and reliability are the result of manufacturer efforts to simplify application procedures and modify chemical composition in an attempt to reduce technique sensitivity.

Manufacturers have also introduced sophisticated light-curing devices with the hope of further improving the clinical performance of direct resin restorations. The latest generation of curing units combines high intensity with short exposure times to save the clinician and the patient chair time. Less favorable with high-intensity lights, however, is the expected incomplete cure of composite resin coupled with an increase in stress development at the cavosurface margins.[5,6] The importance of restoring enamel and dentin as two different substrates and the use of appropriate layering and curing techniques have been stressed so that clinicians may reliably perform Class II direct resin restorations.[7] The application of the aforementioned protocol to compromised posterior teeth has resulted in outstanding clinical performance after 30 months.[8]

Most recently, a commercial device has been introduced to allow heating of composite resin chairside. The composite resin is placed into the prepared cavity with a temperature between 37°C and 68°C. As the temperature is raised, the mobility and collision of trapped radicals increases, thus increasing the conversion rate. For this reason, a newfound interest in thermal-assisted composite resin photopolymerization as an adjunctive means to improve composite properties and reduce curing times has been noted.[9-11]

Case Presentation

A 22-year-old female patient presented with an amalgam restoration on tooth #19(36). Recurrent decay and marginal breakdown required the replacement of the existing restoration (Figure 1). A treatment plan involving a direct resin restoration was accepted and informed consent was secured.

A rubber dam was placed and the cavity was prepared in a conservative manner, removing the amalgam restoration with a round carbide bur and eliminating decay with a #331D pear-shaped diamond bur (Brasseler USA, Savannah, GA). Sharp angles were rounded with #12 and #14 round burs, all without having to bevel the occlusal or gingival surfaces. A sectional matrix was placed to

Figure 1. Preoperative view of tooth #19(36) with recurrent decay and marginal breakdown.

Figure 2. Occlusal view after rubber dam placement and elimination of the amalgam restoration and decay.

reconstruct the mesial surface, secured in place with a wedge, and etched (Figure 2). The etchant was rinsed away, and a fifth-generation adhesive (ie, Gluma Comfort Bond, Heraeus Kulzer, Armonk, NY) was placed in the preparation and light cured for 20 seconds from the occlusal surface using a quartz tungsten halogen curing light (Figure 3).

A microhybrid resin (ie, Venus, Heraeus Kulzer, Armonk, NY) was used to restore tooth #19; several other microhybrid composites (eg, Point 4, Kerr, Orange, CA; Esthet-X, Dentsply Caulk, Milford, DE) could have been used for this step as well. A Calset unit (AdDent Inc, Danbury, CT) was used to thermally enhance (ie, warm up) the composite resin. The heated composite compule was loaded into the syringe gun and allowed to cool for five seconds in order to improve handling. Both enamel and dentin shades were subjected to this thermal-assisted polymerization process. The layering and curing technique adopted to build up the restoration was based on a previously described protocol (Table).[7]

Stratification began through the placement of multiple 1-mm to 1.5-mm triangular-shaped layers of neutral-shaded resin (ie, T2) placed in the apico-occlusal region. They were positioned to strategically reconstruct the gingival and occlusal enamel proximal surfaces (Figure 4). This uncured composite was condensed and sculpted against the cavosurface margin and sectional matrix, and each increment was pulse cured for three seconds at 300 mW/cm^2 to avoid microcrack formation. The enamel peripheral skeleton of the restoration was built up to replicate natural occlusal anatomy. An increased C-factor (ie, the ratio between bonded and unbonded surfaces) resulted as a consequence of this layering technique; polymerization stresses increased as well.[12] In this context, the application of wedge-shaped increments of composite resin was of paramount importance,

Figure 3. An ethanol water-based adhesive system was applied on both the enamel and dentin.

Figure 4. The mesial-proximal surface was built up first, and a 1-mm to 1.5-mm–layer of flowable composite resin was applied on deeper dentin.

Table

Photocuring Times and Intensities Used to Polymerize Enamel and Dentin Buildup.

Buildup Location	Composite Shade (Venus)	Polymerization Technique	Intensity (mW/cm^2)	Time (Seconds)
Proximal Enamel	T2	pulse	200 + 300	8 + 40
Dentin	A3.5 to A3-A2	progressive curing	300	40
Occlusal Enamel	T2	pulse	200 + 600	3 + 10 (occlusal) 10 (facial) 10 (palatal)

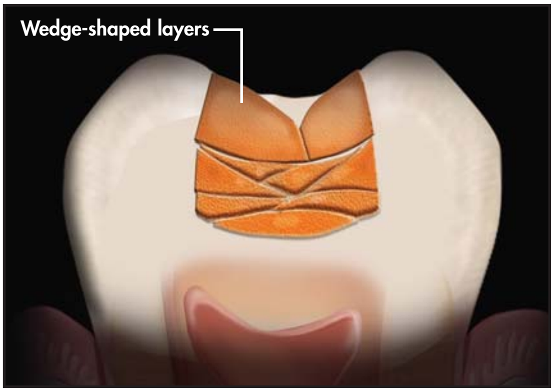

Figure 5. Faciolingual cross-section showing wedge-shaped increments of composite used to build up enamel and dentin.

Figure 6. Dentin stratification was completed using wedge-shaped increments of dentin shades.

Figure 7. The restoration was completed with the application of T2 shade to the final contour of the occlusal surface.

Figure 8. Postoperative occlusal view showing the definitive resin restoration.

resulting in a final total decreased C-factor ratio (Figure 5). At this point, stratification of dentin was started by placing a 1-mm to 1.5-mm–layer of A2 flowable composite (ie, Venus Flow, Heraeus Kulzer, Armonk, NY) on deeper dentin (Figure 4). Final polymerization of both flowable composite and microhybrid composite proximal surfaces was then completed at 300 mW/cm^2 for 40 seconds. Dentin stratification was completed by the application of dentin-shaded wedge-shaped increments strategically placed as single layers to avoid contact between opposing cavity walls (Figure 6). 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 of 20 seconds at 600 mW/cm^2.

As most of the occlusal surface was missing, particular attention was paid during the creation of the correct anatomy; the clinician used the proximal, lingual, and facial surfaces as spatial references. Each cusp was built up separately, and enamel layers of microhybrid resin were applied to the final contour on the occlusal enamel surface with a successive cusp buildup technique (Figure 7). To minimize microcrack formation on the remaining wall and reduce stress from polymerization shrinkage, a combination of pulse and progressive curing techniques was used (Table).[7]

The rubber dam was removed, occlusion checked, and the restoration was finished. Polishing was performed using impregnated silicon rubber cups and points, while final polishing was performed using diamond and silicon carbide impregnated cups, points, and brushes (Figure 8).

Composite Warming Protocol

The authors used both a soft-start polymerization protocol[7] and a thermal-assisted composite polymerization technique[13] to complete a Class II composite resin restoration; this combination may help to improve the physical and mechanical properties of the restoration in the medium and long-term period. With soft-start polymerization, more time was available for warmed composite flow into the cavity walls, resulting in stress release during polymerization shrinkage and increased cross-linking.

Although observed by the authors, this assumption needs to be tested longitudinally and such a test is presently unavailable. Trujillo et al[9] and Daronch et al[10] reported that preheating composite resin prior to photoactivation provided greater conversion and required less light exposure than with room temperature composite. Studies have supported the theory that the duration of light exposure could be reduced by 50% to 75% when using prewarmed composite resin. These studies, however, were conducted in vitro and limited to selected composite resin.[9] While encouraging, clinicians need to consider the experimental nature of these curing protocols. In the present study, the authors used a thermal-assisted polymerization technique and safely maintained conventional, clinically tested curing times and intensity protocols based on soft polymerization (Table).[14]

At room temperature (ie, 24°C), a warmed composite resin cools more rapidly than it does when placed in direct contact with the tooth cavity walls (ie, 37°C). This can cause difficulty for the clinician when attempting to achieve a correct contact point, especially in Class II composite restorations, as well as proper anatomical sculpturing of occlusal and facial surfaces. Increased stickiness of the composite resin to metal composite placement instruments may also occur.

The temperature of the composite resin at the time of delivery is paramount to avoid thermal insult to the pulp. Although placement of a 37°C preheated composite resin in the cavity has resulted in a slight temperature rise in the pulp chamber, insult to the pulp may occur with higher temperatures predicated on several factors (eg, dentin thickness, presence of microcracks, light intensity, thermal diffusivity). To overcome these issues in the current study, composite resin was prewarmed at the lower temperature (37°C) and allowed to cool for five seconds at room temperature before placement in the cavity. The authors established five seconds as the most appropriate waiting period to achieve optimum handling for the 37°C, prewarmed microhybrid composite. Chemical composition and shade may influence viscosity; different composite resins may require a higher prewarming temperature and altered waiting periods to achieve ideal sculptability. A higher prewarming temperature may also be selected for devitalized teeth.[15]

Daronch et al reported that benefits from prewarmed composite resin can still be maintained using temperatures around 30°C to 40°C with regard to degree of conversion.[10] The risk of intrapulpal temperature change can be reduced by placement at a lower temperature. Clinicians should also keep in mind that the temperature rise in the composite resin may vary between 9°C and 16°C during the polymerization process using medium- and high-intensity curing lights.[16,17]

Conclusion

Thermal-assisted composite resin photopolymerization may represent an improved adjunctive means of placing aesthetic restorations. Clinical performance may be enhanced by improvement of a composite resin's physical and mechanical properties. Clinicians need to be aware of composite resin formulation and shade; they will need to customize their composite warming protocol to match the chemistry of each composite resin used. Further laboratory and clinical research studies are required to completely understand the potential advantages from thermal-assisted composite polymerization.

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