A 'Recipe for Success' with Posterior Composites Utilizing Preheated Resins

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It has been nearly four decades since the introduction of direct posterior composite resins as an alternative to metallic restorations, most specifically amalgams. They were first met with doubt and skepticism which was borne out of myriad shortcomings, including the following: poor wear resistance, microleakage, bodily fracture, marginal breakdown, recurrent decay, postoperative sensitivity, inadequate interproximal contacts and contours, color degradation, and inability to polish or maintain polish.[1-10] Couple these physical and mechanical failings with erroneous placement techniques and a lack of knowledge as to how these materials would respond in the posterior segment of the mouth, and one can readily see that the potential for success by the early adapters of composites was greatly challenged.[11-14]

BACKGROUND

In today's contemporary dental practice, it would be hard to imagine being able to meet the restorative demands of our patients without the use of resin-based materials. Specifically, direct composites offer the dental professional one of the most cost-effective methods in which to restore a patient's dentition in an aesthetically pleasing manner. As consumer interest in personal dental health increases, along with a push for metal-free restorative options, the dental profession ha s risen to the call through the research and development of materials and techniques to enhance our ability to deliver quality dental care. However, even with all the scientific and clinical advancements in direct composites, they are still markedly different in their chemical makeup, physical properties, and placement techniques. Yet, many of the same restorative concepts and principles for metal-based restorations are still being utilized with these adhesive resin fillings. This continues to perpetuate concerns related to microleakage, secondary caries, and sensitivity, and directly contributes to the relatively short longevity of composite restorations experienced by some practitioners. It is imperative that dentists modify their mindset and approach to placement of posterior adhesive restorations in their diagnosis, preparation design, isolation of the site, material selection, adhesive implementation, placement method, light curing time and intensity, and finishing and polishing techniques.

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One aspect of composites, which has in recent years been a focus of research, is the effect that preheating has on the physical and mechanical properties of the resin.[15] This is quite surprising considering the amount of information in the literature related to the physical attributes of heat-curing composites in indirect fabrication of inlays and onlays.[16-22] The following is a restorative protocol for maximizing the benefits of direct composites as a posterior restorative through the use of prewarming the resins prior to placement in order to provide improved flowability, better adaptation to the preparation, reduce microleakage, increase hardness and conversion percentage, and reduce curing time.

CLINICAL AND TECHNICAL CONSIDERATIONS

The basic clinical requirements for a direct composite are as follows: one that is easy to place in the mouth, polymerizes readily, is aesthetically pleasing, and has good longevity when compared to alternative restoratives. For all its positive attributes, a major downside to direct composites (that is well documented in the literature) is the fact that all resins demonstrate polymerization shrinkage when exposed to a visible light-curing source.[23-25] As a result, this creates a challenge to the dentist when placing a composite. Most of the recent research has focused on various investigations of light intensity, length of curing time, modality and application of the curing light source, achieving proper isolation and marginal seal, and other considerations too numerous to discuss at length within the scope of this article. However, a few key concepts that play a role in a successful posterior composite warrant discussion to better grasp their importance.

The marginal adaptation of the composite to the tooth interface, as well as the integrity of the bond, is critical to the long term success of any direct composite.[26] This is especially true in the posterior region of the mouth. This is an area that is not easily accessible to a periodic visual exam and restorations are placed based on the faith in one's ability to isolate the bonding site. The polymerization of the resin begins the conversion of the monomer molecules into a polymer matrix, which leads to contraction. This bulk contraction (polymerization shrinkage), is seen as a volumetric decrease during the curing process.

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The material transforms in phases; from a viscous, to viscous-elastic, to elastic in nature. In the viscous stage, stress is nonexistent. However, during the viscous-elastic stage, stresses occur in the material and at the material-tooth interface.[27] Shrinkage stresses are transferred to the cavity walls of the tooth due to volumetric changes in the composite.[25,27]

These stresses, and the resulting polymerization shrinkage, can be influenced by material selection,[28] filler content,[28-30] intensity of the light source,[27,31] curing characteristics of the resin,[32] water sorption,[33,34] and cavity prep configuration.[35] In particular, certain cavity preparation forms lack free surfaces to absorb the stress, as noted by the ratio between free and bonded surfaces, known as the C-Factor.[36] If this ratio is high, as in a class I configuration, it can create shrinkage stresses that are higher than the dentin/enamel bond formed by the bonding agent. Consequently, this can lead to partial delamination at the marginal interface, thus creating gaps and/or enamel fractures.[37] Many options have been proposed to limit these stresses, including the following: the use of liners and bases, alteration of light intensity, incremental layering, increased filler content, and modification of bonding techniques. Unfortunately, none of

FIGURE 1—Calset (AdDent) heating unit with dispenser gun insert and additional compules warming on the tray.

FIGURE 2—Calset veneer warming tray allows the clinician to use a traditional body composite for cementation of all-ceramic veneers by lowering the viscosity of the material.

FIGURE 3—Conservative preparation on tooth No. 13 to gain access to distal caries.

FIGURE 4—Glass ionomer liner base placed in the area of deeper caries excavation, acting as a dentin substitute.

FIGURE 5—Cavosurface bevels created on the occlusal and proximal line angles.

these can fully compensate for the effects of this phenomenon.

The use of flowable composites has also been touted as a way to ensure a more intimate contact with both the dentin bonding agent and internal surfaces of the prep, and to augment the seal obtained by a composite at the cavosurface margin.[37-39] Flowable resins are less filled than traditional composites, and therefore shrink more due to the decreased filler content. This could be problematic in restorative techniques when a large volume of flowable composite is used in an attempt to improve the seal and marginal adaptation of the composite. Understanding the correlation between polymerization shrinkage stresses and adhesion assists the dentist in selecting the appropriate combination of technique and restorative materials to prevent gap formation during the placement process.

HEATING DIRECT COMPOSITE RESINS BEFORE PLACEMENT IMPROVES PROPERTIES

One method to improve our technique is to take advantage of the same "negative" properties that composites possess, and to turn them into "positives" by manipulating the temperature of the composite prior to placing it into the preparation. As the temperature of a composite increases, the viscosity decreases and the material becomes more flowable. This allows for easier placement of the composite, and improves adaptation of the resin to the preparation. When heated to a specific temperature, a traditional composite achieves enough flow to improve its marginal adaptation without compromising the physical properties of the restorative material.[40] A composite heating unit (Calset [AdDent] Fig. 1) was specifically developed to heat composite to a preset temperature of 98°F, 130°F, or 155°F; depending upon the operator's preference. This significantly decreases the viscosity of the material, thus allowing for enhanced marginal integrity.[41]

In additional studies, it was found that preheating composite resulted in significantly less microleakage at the cervical margin, when compared to the control or the use of a flowable resin.[42-44] The use of pre-warmed composite materials also has the benefit of increasing the degree of conversion and surface hardness of the polymerized resin, reducing curing time, and also improving the depth of cure. As a response to the profession's interest in improving the bonding of all-ceramic veneers, there is also a warming tray for warming ceramic veneers. This allows the clinician to use traditional composite materials,

FIGURE 6—Clear matrix band, sectioned wedge, and retainer placed to gain proper isolation of the bonding site and to assist in the achievement of a tight interproximal contact.

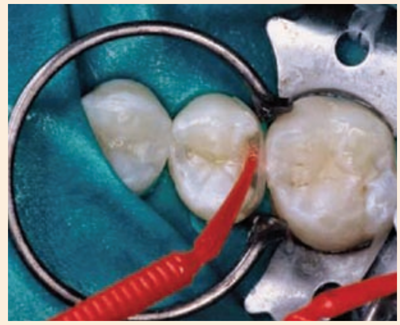

FIGURE 7—Application of a 7th-generation self-etch enamel and dentin-bonding agent.

which have better physical properties and lower shrinkage than flowable resin cements, by lowering the viscosity of the material through pre-warming (Fig. 2).

Numerous studies have shown that the degree of conversion is enhanced at higher temperatures and occurs more rapidly.[45-47] Composites create highly cross-linked networks during polymerization and the degree of conversion for most direct materials ranges from 45% to 70%. The rate of polymerization and the degree of conversion are affected by the comonomers and photoinitiators used, filler and particle size of the composite, and the interactions between the fillers and monomers. Trujillo, et al[46] determined that regardless of the type of curing light or composite material used, the immediate and final conversion values were significantly higher with a preheated resin, when compared to room temperature photo-curing. The clinical significance of these findings is that the curing time at the chair can be reduced by 50% to 80% to obtain a relevant degree of cure and hardness.

In another study, Bortolotto and Krejci[48] found that the temperature at which a composite was placed into the cavity preparation had a marked influence on the hardness of the composite. Their results showed when temperatures were raised from 5°C to 40°C, significant increases in Vickers Hardness occurred at a curing depth of 0.5mm. More recently, Bond, et al[49] confirmed their results, showing that there was a statistical significance in hardness when measured from both the top and the bottom of the sample as the temperature of the composite was raised from 70°F to 140°F, then cured with either an LED or halogen light source.[49] All these attributes not only contribute to a better restoration, but improve the chairside efficiency of the operator as well.

Some concerns may arise related to the preheating of resins, especially if the composite were to be heated over an extended period of time by leaving it in the Calset unit. To the contrary, compules can be warmed for up to eight hours without causing any negative changes that could initiate undesired polymerization. Another concern, in introducing pre-heated composites into the cavity prep, could be related to the effect that the elevated temperature might have on pulpal tissues. F. A. Rueggeberg found that the maximum intrapulpal temperature rise from the application of a composite heated to 130°F was approximately 2.9°F when 1mm of dentin remained (unpublished data, 2008). This is well below the established

FIGURE 8—The pre-heated composite compule is removed from the Calset unit and syringed into the preparation.

FIGURE 9—The heated composite is condensed into the cavity prep with a P-1 Plugger (Ivoclar Vivadent). By being warmed to 130°F, the composite has a more fluid consistency and adapts well to the cavity walls and margins, thus eliminating the need to use a flowable prior to placement.

FIGURE 10—The Composite Contact Former (American Eagle) is introduced into the warm composite and is used as a fulcrum to not only help create a tight interproximal contact, but place it in the ideal location.

threshold for pulpal tolerance reported in the literature.[50] Consequently, the operator can, with great confidence, benefit from the many attributes which the preheating of composites offer in order to improve restorative care to their patient.

CASE REPORT

The numbers of techniques cited in journals, research papers, and presented in continuing education courses are far too voluminous to mention without failing to credit all those who have contributed to the ongoing refinement of posterior composite restorations. Tak_ ing into account all the variables involved with the use of direct resin materials, one must find a predictable, efficient method that offers a reproducible and consistent result and meld that with current research information. This can enhance and improve our final restorations and help meet our goals for the patient. A step-by-step technique or recipe for success follows which incorporates a straight-forward approach that has been modified and improved over the years as we continue the goal of refining and advancing our results in the direct composite arena.[51]

A 22-year-old female patient presented for a new patient exam. Interproximal caries were detected radiographically on the distal aspect of tooth No. 13. Restorative options that were presented to the patient included: an amalgam, a cast gold inlay, a ceramic or composite indirect inlay, and a direct composite. The patient chose to proceed with the direct composite resin based on the physical characteristics, aesthetics, the ability to conserve tooth structure, costs, and the desire to have a nonmetallic restoration.

Options that were presented included: an amalgam, a cast gold inlay, a ceramic or composite indirect inlay, and a direct composite

The Carbocaine 2% with neocobefrin 1:20,000 (Kodak Dental) was used to anesthetize the tooth. A rubber dam was placed to aid in isolation of the site. A conservative preparation was created using a pear-shaped bur (330 carbide bur [Brasseler USA]) to gain access to the proximal lesion. (Fig. 3) The remaining decay was excavated and complete removal verified with a caries-detecting dye. Rounded internal line angles were developed in the preparation. This important preparation feature is preferred in direct composites due to the fluid nature of the material and the ability rounded line angles have in dissipating stresses upon function. A glass ionomer (Fuji Filling LC [GC America]) was utilized as a base over the dentin in the area of deeper caries excavation. This acted as a dentin substitute (Fig. 4). Cavosurface bevels were then placed in enamel on the occlusal surfaces. Next, the proximal enamel line angles were rounded using a flame-shaped 40-µm grit diamond (Brasseler USA) to eliminate loose and fractured enamel rods that might otherwise compromise the etch pattern and marginal integrity of the final restoration (Fig. 5).

A matrix system was then secured in order to create proper isolation of the bonding site and to act as a mold due to the fluid characteristics of the composite resin material. A clear plastic, anatomical, posterior Mylar matrix band (Cure-Thru Matrix Bands [Premier Dental Products]) was cut to a segmented shape and placed proximally. It was then secured with an anatomically-contoured wooden wedge (Premier Anatomically Carved Sycamore

FIGURE 11—After curing, the contact-forming instrument is removed to reveal a "hollow." This is then backfilled with a small increment of a flowable resin, followed by a second layer of pre-heated composite.

FIGURES 12 & 13—The second layer of pre-heated composite is shaped and contoured using the P-1 Plugger and a chisel-shaped ceramist brush (Ivoclar Vivadent).

FIGURE 14—After removal of the matrix system and rubber dam, shaping and occlusal refinement are accomplished with a 12-bladed, spiral-shaped carbide (Brasseler USA).

FIGURE 15—Final finishing and polishing are completed with abrasive cups and points (Ivoclar Vivadent).

FIGURE 16—The completed direct composite on tooth No. 13 has a natural, life-like finish.

Wedges, Premier Dental Products) that was sectioned in half, and only the small diameter portion was used. This allows for better seating of the matrix retainer (Palodent [DENTSPLY Caulk]), because the length of a traditional wooden wedge often interferes with the jaws of the retainer that fully engages the prepared and adjacent tooth. The Palodent retainer, together with the sectioned piece of the Cure-Thru band and the downsized wedge, combines to create a matrix system that not only acts as a mold to contain the composite, but also assists in isolation of the bonding site. In addition, this assists in achieving a tight interproximal contact between the restoration and the adjacent tooth (Fig. 6).

The isolated preparation was then cleansed using a solution of sodium hypochlorite on a stiff bristle brush (Benda Brush [Centrix]) in a scrubbing motion for 15 seconds, and subsequently rinsed with a stream of water and lightly air dried. A seventh-generation self-etch enamel and dentin bonding agent (iBond [Heraeus Kulzer]) was applied according to the manufacturer's instructions using a disposable applicator (Fig. 7), then cured with visible light source (iQ LED [DENTSPLY Caulk]).

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A compule of preheated microhybrid composite (Venus Shade A1 [Heraeus Kulzer]) was removed from the Calset tray and syringed into the preparation (Fig. 8). By being warmed to 130°F, the composite had a more fluid consistency and adapted extremely well to the cavity walls and margins. This eliminated the step of using a flowable composite to assist in reducing the potential for voids. The first increment was easily manipulated (due to its flowability) with a P-1 Plugger (Ivoclar Vivadent). Sealing of the cavosurface margins by the heated composite is confirmed visually, made possible by the use of the clear matrix band (Fig. 9). To ensure a tight and properly placed interproximal contact, the Composite Contact Former (CCF) (American Eagle) was introduced into the warmed composite and

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used as a fulcrum between the axial wall of the preparation and the proximal wall of the adjacent tooth (Fig. 10). With the instrument held securely in place, the composite was cured from the buccal and lingual aspects with an LED curing light. By elevating the temperature of the composite, we would improve the physical and mechanical properties as previously described. Warming the composite resin also served to decrease the length of curing time needed for an equivalent degree of conversion.

Removal of the CCF contact former from the cured composite reveals a "hollow" (Fig. 11). This space was backfilled with a small increment of flowable composite (Venus Flow [Heraeus Kulzer]), followed by a second layer of preheated composite (Venus SB1 [Heraeus Kulzer]) as an enamel layer, then condensed and contoured using the P-1 Plugger (Ivoclar Vivadent) and a chisel-shaped ceramist brush (G-2 Ceramist Brush [Ivoclar Vivadent]) (Figs. 12 & 13). The restoration was then cured for an additional 20 seconds from the buccal, lingual and occlusal aspects.

After removal of the matrix system and rubber dam, initial shaping and occlusal refinement of the composite was accomplished with 12-bladed, spiral-shaped carbides in a variety of shapes (Brasseler USA) (Fig. 14). Final finishing and polishing were completed using a series of cups and points, progressing from grey to green, to rose ([OptraPol], Ivoclar Vivadent, Fig. 15). The completed direct composite on tooth No. 13 has a natural, life-like finish (Fig. 16).

CONCLUSION

As patient desires for aesthetic changes and metal-free alternatives continue to grow, direct composite resin restorations offer the dentist a conservative and cost-effective choice to restore the posterior teeth. Improvements in the physical and mechanical properties of restorative materials by manufacturers have improved our ability to place a direct composite resin. Composite resins have gained widespread use in the dental community, but not without a learning curve. Proper placement techniques, as well as respect for the unique nature of resin-based chemistry, must be exacting and reproducible in order to achieve the desired result. Research has shown us that using new technology, by preheating composite resins prior to placement, yields numerous advantages such as improved flowability, better adaptation and reduced microleakage, greater polymerization conversion, increased hardness of the material, and a reduction in curing time. As a result of preheating, these attributes will assist the dentist in creating longer-lasting direct composite resin restorations, and enhances any recipe for success by taking it to a new level. **OH**

Composite resins have gained widespread use in the dental community, but not without a learning curve

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