Warming Up to Composites

CE 2

Abstract: ***Patient demand for composite restorations has increased dramatically over the past decade. Anterior composites, for teeth that are visible when smiling, have been the standards of practice for many years. For the less visible teeth, it is estimated that the 50% mark for composite restorations in the posterior region was surpassed in 2000.[1]***

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The widespread use of tooth-colored fillings has galvanized patient interest in personal dental health and demand for quality dentistry.[2] These successful dental advances are the result of a science that is based on very active research and development, constantly evolving materials and techniques for better patient treatment. The parameters of effective practice have placed the additional burdens of technique and dental material awareness on the practitioner. Dentists are responsible for keeping abreast of the latest innovations for the benefit of their patients.

As more dentists have switched to composite restorations, they have demanded improved properties in these materials. Much of the research of the past few years has focused on alleviating the dental practitioners' concerns by improving the quality and the handling ease of composite resin materials in dental restorations. The ultimate objective is an ideal restoration that is relatively easy to place (not technique sensitive), convenient to polymerize, long lasting, and esthetic. The major issues have included:

1. reducing the curing (polymerization) time
2. increasing the depth of cure
3. increasing the conversion (polymerization) ratio

In the author's observation, over the years, much attention has been paid to parameters such as the intensity of the curing light, the curing time, the application method of the curing light, and the presence of moisture in the restorative field. Scant interest has been taken in the properties of the directly placed composite under varying thermal conditions. This is rather surprising considering that the physical-property advantages of heat-curing composites in the manufacture of extraorally fabricated inlays and onlays have been known for a long time.

1. For many years, dentists were often asked to refrigerate their composites until immediately before use, as well as between patient visits. According to the latest research findings, this is probably the worst possible course of action.[3]

2. To the contrary, the warming of composites to body temperature or somewhat higher immediately before placement with a Calset™,[a] thermal assist unit (Figure 1) has been shown to improve composite properties and reduce curing times.[1,3]

In evaluating the bottom hardness of composites that were cured with a range of light sources, varying only the composite temperature at the moment of polymerization (polymerization temperature), Bortolotto and Krejci[3] found that the insertion temperature had an important influence on

Learning Objectives:

After reading this article, the reader should be able to:

- identify the ideal restoration, as well as the major issues involved in achieving this ultimate objective.
- describe the advantages of prewarming composites by reviewing the literature regarding composite placement at various temperatures.
- demonstrate the clinical technique for prewarming a composite to the ideal polymerization temperature using a heating unit.

[a]AdDent, Inc, Danbury, CT 06810; (203) 778-0200

Figure 1—Calset composite warming unit.

Figure 2—Calset control switch.

Figure 3—Loading warmed compule into syringe gun.

Figure 4—Amalgam with redecay and marginal breakdown.

the hardness of a composite. The restorations inserted with the composite prewarmed to 40°C (only 3°C warmer than body temperature) were significantly harder on the Vicker's scale than the composite restorations inserted at room temperature (22°C). The hardness values at 40°C compared with those where the composite was at 5°C (the approximate temperature of a commercial refrigerator) were approximately double. Another very significant finding was that the curing time for a layer of composite at room temperature could be reduced to half when it was warmed to 40°C, without affecting its hardness properties.[3] Therefore, prewarming a restorative composite to a temperature slightly greater than 37°C can improve the depth of cure of the material and reduce the curing time by 50%.

A study of the conversion values of composites under various thermal conditions by Stansbury provided even more dramatic results.[4] A higher conversion ratio (double-bond formation or polymerization) at a greater depth increases the material modulus, resulting in less flexure and less potential for restoration fracture under loading. Three esthetic materials (microfill, hybrid, and packable) were compared under 3 different light-curing modes (light-emitting diode [LED], halogen, and plasma arc) at 2 different temperatures (23°C and 54.5°C).

The elevated temperature of the composite during photopolymerization resulted in substantially higher immediate and final conversion values in all the tested composite materials, and with all the different curing lights. In fact, the curing time required to achieve similar conversion ratios could be decreased by 50% to 80% when the temperature of the composite was elevated from 23°C to 54.5°C. Therefore, prewarming a restorative composite to a temperature greater than 37°C can improve the conversion rate of the material, with a concomitant improvement in the fracture resistance, and reduce curing time by 50% or more.

Rueggeberg has demonstrated that composite polymerization temperature has a major impact on the required polymerization times. When the filling material was at body temperature, the next 20°C of warmth did not reduce the curing time significantly. At 58°C another major advance in the conversion ratio remained constant for the next 10°C. This indicates that ideal warming of a composite should be either 37°C or a slightly more elevated temperature (58°C). For warmed restoratives, no significant increase of conver-

Figure 5—Preparation is isolated with a rubber dam and sectional matrix.

Figure 6—Applying iBond seventh-generation adhesive.

Figure 7—A prewarmed microhybrid is flowed into the marginal areas and cured.

Figure 8—The completed restoration.

Figure 9—The top segment of the Calset can be removed and transported independently.

sion occurred as the curing times went from 20 seconds to 60 seconds. Thus, shorter curing times can be recommended. Therefore, the ideal prewarming temperatures for a restorative composite are scientifically established, and most curing times for a prewarmed composite can be reduced to 20 seconds.

A study by Littlejohn and colleagues measured the percentage of composite conversion at various polymerization temperature levels. A significant improvement in conversion from room temperature to body temperature was found.[5] Therefore, a composite warmed at least to 37°C before insertion into the tooth cavity is likely to be a better restoration with improved physical properties, both in the short and the long term.

In the author's opinion, in recent years the use of flowable resins in large posterior restorations has helped achieve better marginal adaptation, particularly with packable composites. But this technique involves a restorative compromise. According to a conversation with Karl F Leinfelder, DDS (April 2001), the low viscosity of the flowable composites is achieved by decreasing the filler concentration. According to the same conversation with Dr. Leinfelder, this, in turn, increases the proportion of resin in the composite resin and the polymerization shrinkage.

Viscoelastic materials such as composite resin exhibit decreased viscosity and greater flowability with an increase in temperature. In a study by Holmes and colleagues[6], the film thickness of a microhybrid composite decreased by approximately 30% when the material was heated to 54°C. Thus, it is possible to use a flowable and highly filled prewarmed hybrid or packable composite at the gingival margins of a deep restoration, eliminating a technical compromise that has existed for several years.

One concern that arises is the effect of the composite heat on the dental pulp and the possibility of iatrogenic thermal damage. A study by Rueggeberg (written communication, May 2001), indicated that the maximum intrapulpal temperature rise from the application of a 57.2°C composite material was approximately 1.6°C, well within the established pulpal tolerance of more than 10°C.[7]

Clinical Technique

The preparation for prewarming a composite to the ideal polymerization temperature is rather straightforward.

1. The Calset unit is turned on; press the control switch once (Figure 2). Note that the amber LED indicator illuminates to indicate that the unit is functioning normally.
2. The green LED flashes to indicate the warming of the composite, which typically takes approximately 10 minutes to reach 55°C, or 130°F.
3. When the desired temperature has been reached, the green light shines steadily.
4. The heated composite compule is loaded into the syringe gun (Figure 3), and the material is applied directly to the tooth.

The amalgam restoration (Figure 4) shows signs of redecay and marginal breakdown. The old filling is removed, and the preparation is isolated with a rubber dam and a sectional matrix (Figure 5). The preparation is treated with iBond™[,b], a seventh-generation, single-bottle, single-step adhesive that requires no acid etching (Figure 6). A prewarmed microhybrid, Venus™[,b] is flowed into the marginal areas and cured (Figure 7).

In the past, heavily filled materials, particularly packable materials, have had difficulty in achieving good marginal adaptation.[8] The heated microhybrid has a flowable consistency, conforming very accurately to the marginal areas. The adaptation of the composite into the nooks and crannies of the preparation is improved as a result of its elevated temperature flowability.[8] As each increment of composite is placed and cured at its ideal polymerization temperature, the curing at the elevated temperature will provide the improved physical and mechanical properties. The composite is placed incrementally according to conventional techniques until the occlusal surface is completed. It then is finished and polished routinely (Figure 8).

[b]Heraeus Kulzer, Inc, Armonk, NY 10504; (800) 431-1785

5. The top segment of the Calset unit can be removed from the heater and transported independently to a remote location (Figure 9). This part of the unit has no electrical cords. The design of the Calset allows the top segment to act as a heat sink that keeps the composite warm for several minutes. If the composite is forgotten in the Calset unit, the properties of the composite are not affected negatively even after 8 hours of warming.[3]

Conclusion

The era of curing composites under elevated thermal conditions, long accepted and practiced in the fabrication of extraoral composite restorations, is now available for direct intraoral composite restorations. The early research, confirmed by clinical practice, indicates that this is a practical means of rapidly and easily improving composite properties in dental restorations.

Disclosure

[Author: Please return the conflict of interest form.]

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Quiz 2

1. **For composite resin materials in dental restorations, the major issues have included:**
   a. reducing curing (polymerization) time.
   b. increasing the depth of cure.
   c. increasing the conversion (polymerization) ratio.
   d. all of the above

2. **The hardness values at 40°C compared with those where the composite was at 5°C were approximately:**
   a. the same.
   b. double.
   c. triple.
   d. quadruple.

3. **When the filling material was at body temperature, the next how many degrees of warmth did not reduce the curing time significantly?**
   a. 10°C
   b. 20°C
   c. 30°C
   d. 40°C

4. **Most curing times for a prewarmed composite can be reduced to:**
   a. 80 seconds.
   b. 60 seconds.
   c. 20 seconds.
   d. 10 seconds.

5. **In a study by Holmes and colleagues, the film thickness of a microhybrid composite decreased by approximately what percentage when the material was heated to 54°C?**
   a. 10%
   b. 20%
   c. 30%
   d. 40%

6. **A study by Rueggeberg (written communication, May 2001) indicated that the maximum intrapulpal temperature rise from the application of a 57.2°C composite material was approximately:**
   a. 0.02°C.
   b. 1.6°C.
   c. 3.9°C.
   d. 10°C.

7. **The established pulpal tolerance is more than:**
   a. 2°C.
   b. 10°C.
   c. 20°C.
   d. 30°C.

8. **In the Calset unit, the green LED begins to flash to indicate the warming of the composite, which typically takes approximately how much time to reach 55°C, or 130°F?**
   a. 1 minute
   b. 10 minutes
   c. 30 minutes
   d. 1 hour

9. **The design of the Calset allows the top segment to act as a:**
   a. heat sink.
   b. stabilization platform.
   c. liquid reservoir.
   d. light reflector.

10. **If the composite is forgotten in the Calset unit, the properties of the composite are not affected negatively even after how many hours of warming?**
    a. 8
    b. 12
    c. 24
    d. 48

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