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by David S. Hornbrook, DDS

Achieving Clinical and Functional Success When Fabricating a Microhybrid Composite Inlay
by David Grin, CDT

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3M ESPE and Dental Learning Systems are pleased to present the first issue of a new clinical series, Synergy in Dentistry, for the dental professional and laboratory technician. This publication will offer 2 hours of continuing education in 3 issues—February, June, and September 2002. The goal of this series is to foster and strengthen the alliance between the dentist and the laboratory, enabling better communication and clinical results.

Resin materials have been used in indirect restorative dental procedures for the last 50 years. Early formulations were used in conjunction with metal substrates because of their inadequate physical and mechanical properties. Their clinical shortcomings included poor wear resistance, marginal discoloration, and bulk discolorations. After the introduction of filled composite resin materials, additional attempts were made in the late 1970s to mid 1980s with laboratory-fabricated restorations. Once again, inadequate physical and mechanical properties resulted in premature failures such as composite fractures when stressed and discolorations at marginal areas.1,2

Significant progress appears to have been made in recent years with newly formulated composite resins for indirect applications. Specifically, applications involving inlays and onlays have shown the most promising clinical behavior in posterior teeth.3 The introduction of Sinfony™ indirect lab composite (3M ESPE) is representative of recent technology that uses a category of composite resins referred to as the “microhybrid composites” for indirect restorative applications. The following articles by Dr. Hornbrook and Mr. Grin provide a comprehensive review of the evolution of this innovation in an indirect microhybrid composite. Their specific clinical applications are focused on examples in posterior inlay restorations. Both authors provide thorough details on how to achieve optimum results when using Sinfony™ in the identified clinical applications. While the long-term behavior of this class of restorative is presently unknown, very favorable laboratory data and limited clinical results suggest that a promising technology may have finally arrived for the clinician focused on achieving optimum esthetics in restorative procedures.

Sincerely,

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A Clinical Technique for Placement of an Indirect Microhybrid Composite Inlay

ABSTRACT
For years, dentists have sought a durable indirect restorative alternative to porcelains and ceramics that would demonstrate clinical and material characteristics suitable for a variety of functional and esthetic indications. With major enhancements to the mechanical and physical characteristics of composite materials has come the introduction of indirect alternatives that enable dentists to place conservative, durable, and esthetic restorations. This article discusses the historic shortcomings of earlier generations of indirect composites, details the clinical benefits of a new-generation, indirect microhybrid composite (Sinfony™, 3M ESPE), and presents a clinical technique for placing a mesio-occlusal inlay fabricated with this material.

Learning Objectives
After reading this article, the reader should be able to:
• discuss the rationale for using an indirect resin restoration.
• describe the basic preparation, impressioning, and shade determination of the resin restoration.
• explain the bonding procedures using a new, dual-cured, resin cement with a single component adhesive.

Dentists have long sought an indirect material suitable for a variety of restorative indications, including full-coverage crowns and bridges, veneers, and inlays/onlays. Porcelains and ceramics have predictably served the dental profession for more than 200 years, but have also presented a number of clinically undesirable characteristics, including harsh wear of opposing teeth. Manufacturers have responded with a variety of indirect composite resin materials suitable for anterior and posterior restorations.

This class of restorative material has evolved greatly since 3M ESPE introduced one of the first BIS-GMA composites in 1964. Indirect laboratory composites may provide many attractive attributes for restorative procedures, including kindness to opposing dentition, ease of use, esthetics, placement with adhesive techniques, conservative preparation requirements, and resilience. However, despite improvements in filler, coupling agents, and polymers, resistance to wear has been a concern that has limited more widespread use of this material. Therefore, major efforts have been made to enhance the mechanical and physical characteristics of indirect composites to better mimic porcelain for specific clinical applications. These include the addition of new resins, fiber reinforcement, and photopolymerization techniques. As a result, today’s indirect composites (including Sinfony™, 3M ESPE), belleGlass™ HP, Targis Vectris™, and Artglass®) demonstrate superior mechanical properties, wear, and clinical performance, and enable dentists to provide patients with functional and esthetic restorations. While these innovations cannot address every restorative challenge, enhancements to indirect resin alternatives enable dentists to use conservative preparation designs and varying surface treatments to achieve functional and esthetic results.

Material Characteristics
The indirect material used in this case is Sinfony™, an ultrafine particle microhybrid composite designed for laboratories to build and layer in a manner similar to porcelain. Indicated for inlays/onlays, veneers, and full-coverage crown restorations, this material demonstrates exceptional flexibility, impact strength, and color stability, as well as lifelike esthetics and translucency. In addition to superior wear resistance, Sinfony™ is easy to finish and polish, and is plaque and stain resistant.

The physical properties of Sinfony™ include enhanced strength compared to earlier generations of indirect laboratory composites. Sinfony™indirect laboratory composite measured higher in flexural strength—105 MPa—compared to three other materials. Because Sinfony™ has a lower flexural modulus, the material is less brittle, making it ideal for veneering over flexible understructures, such as fiber bridge substrates or telescope crowns. Further, in transverse impact tests conducted internally by 3M ESPE, Sinfony™ demonstrated an impact strength of 7.5 mJ/mm, surpassing other materials that are relatively brittle and unable to satisfy the demands of modern veneering materials. Additionally, the material’s compressive strength of 275 MPa represents significant advantages over 2 out of 3 alternate indirect composites.

In solubility tests, which are associated with water repellency of the polymer matrix, Sinfony™ demonstrated a significantly low solubility of 19 µg/mm (60 days). In both a mastication-simulator machine and a three-media-wear machine, Sinfony™ showed significantly less abrasion than other materials at 175 µm, exhibiting low-wear characteristics.

The processing and layering technique used in fabricating Sinfony™ restorations ensures the enhanced physical properties noted, in addition to a natural vitality and opalescence.
cent and fluorescent effects. The material is easily matched to surrounding teeth by building up Vita®c shades in a manner similar to porcelain—flowing onto the surface without entrapping bubbles. Sinfony™ restorations can be seated using enamel/dentin adhesive bonding or traditional cementation techniques when placed with a metal substructure.

When used in combination with adhesive materials specifically designed for use with indirect procedures, such as 3M ESPE Single Bond® and 3M ESPE RelyX™ ARC®, Sinfony™ produces exceptional bond strengths. 3M ESPE RelyX™ ARC bonds indirect restorations securely, yet demonstrates easy handling and cleanup characteristics without compromising its adhesive or physical properties. Further, 3M ESPE Single Bond has been repeatedly shown to produce exceptional shear bond strengths when applied to enamel (>30 MPa) and dentin (>22 MPa).13

Case Presentation
A 42-year-old man presented with a failing mesio-occlusal composite restoration on tooth No. 18 (Figure 1). To maintain the conservative and esthetic nature of his previous dental work, planned treatment involved replacing the defective restoration with a microhybrid, indirect, mesio-occlusal inlay using Sinfony™.

Clinical Technique Preparation
The preexisting composite restoration was removed using a tapered, flat-ended diamond (Axis 845KR®) (Figure 2), maintaining as much healthy tooth structure as possible. All internal line angles were rounded, a 5- to 7-degree taper of preparation walls was established, and undercuts were removed. A butt-joint margin was placed at the proximal gingival margin. All margins were smoothed using a 30-µm finishing diamond to eliminate any roughness.

Impression Making
Impressions were made using a polyvinyl siloxane (PVS) impression material in a full-arch tray. The technique used a wash material placed around the preparation and on the surrounding occlusal surface. The tray
was loaded with a rigid heavy-body material at the same time the wash was placed around the preparation and inserted into the mouth. Accurate reproduction and detail is imperative to achieve a well-fitting restoration. A rigid PVS bite registration material was used to capture the bite relationship. An opposing impression was made using a medium-body PVS impression material, and a facebow (Stratos 200®) was taken.

Shade Selection

The shade was chosen by identifying dentin and enamel shades separately. Using the Vita® shade guide, a dentin shade was chosen by matching the gingival third of the buccal surface of the adjacent tooth. The enamel shade was taken from the remaining occlusal enamel on the prepared tooth. Occlusal stain was noted and identified for the ceramist by photographing a nonrestored tooth on the opposing arch. It was also requested that the restoration be very translucent at all margins to facilitate blending into the surrounding tooth structure.

Provisionalization

Provisionalization was achieved using a BIS-Acryl provisional material (3M ESPE Protemp® Garant®). A preoperative impression was made using a half-arch triple tray loaded with a medium-body, fast-setting PVS impression material. After preparation and master impressions, the preoperative impression was loaded with the BIS-Acryl material and seated back in the mouth for 2 minutes. After 2 minutes, the impression was removed and the BIS-Acryl provisional was teased out of the impression, trimmed, and placed back into the preparation. After a total of 4 minutes, the provisional was removed, trimmed using an aluminum oxide disc (3M ESPE Sof-Lex™ R Disc®) and 16-fluted carbide burs, and tried back in the mouth. Occlusal equilibration of the provisional was accomplished using a 16-fluted football-shaped carbide bur. The provisional was cemented using a resin-based, dual-cured provisional cement (Provilink®,) and polished with composite finishing points and cups (Astropol®).

Placement of the Final Restoration

The provisional restoration was removed using a sharp scaler placed under the proximal height of contour. Because a resin-based provisional cement was used, there was minimal cement to clean from the preparation. A rubber dam was placed to isolate the preparation (Figure 3). The preparation was cleaned using a chlorhexidine solution in a syringe with a brush tip (Figure 4). The restoration was then seated into the preparation to ensure complete seating and marginal adaptation, and the proximal contact was checked (Figure 5). The restoration was removed and cleaned with 35% phosphoric acid to remove any contaminants and to create an acidic surface, and then rinsed and dried. A silane coupling agent (3M ESPE RelyX™ Ceramic Primer®) was applied to the internal surface of the inlay and allowed to sit undisturbed for 1 minute. This was then air-dried with moisture-free air, and a single-component adhesive agent, 3M ESPE Single Bond, was thinly applied to this surface. The inlay was then placed in a light protective container (Vivapad®).

The enamel and dentin surfaces were etched for 15 seconds with 35% phosphoric acid and rinsed for 5 seconds (Figures 6 and 7). A polyester-tufted brush was used to remove excess moisture from the tooth surface without desiccation (Figure 8). 3M ESPE Single Bond was applied to the enamel and dentin in multiple coats for 20 seconds (Figure 9). A source of moisture- and oil-free air was used to evaporate any excess alcohol solvent for 15 seconds. The adhesive agent was then polymerized with a halogen light for 10 seconds. 3M ESPE RelyX™ ARC was mixed and placed into the preparation (Figure 10). This cement was chosen because it establishes a preliminary chemical polymerization to a gel-like consistency that facilitates easy cleanup and removal of excess cement. A warm shade (A3) was chosen to help establish a chameleonlike result.

The inlay was seated in the preparation with moderate pressure for 3 minutes to ensure complete seating (Figure 11). Moderate pressure was applied with a blunt-tipped instrument throughout the 3 minutes. Then, an explorer was used to carefully peel away the excess cement from the margins (Figure 12). Floss was used to remove excess interproximal cement.

An oxygen inhibitor (DeOx®) was placed on all margins to eliminate the formation of an oxygen inhibition layer (Figure 13). The restoration was then polymerized using a halogen light for 90 seconds to ensure complete polymerization of the resin cement. The oxygen inhibition medium was rinsed, and any excess cement was removed.
using a scaler and scalpels (Bard Parker 12B) (Figure 14). Rough margins were smoothed using a 15-µm finishing diamond. The interproximal gingival margin was finished using a thin aluminum oxide strip (3M ESPE Sof-Lex™ Strip) (Figure 15). The occlusal surface was adjusted using composite finishing diamonds, and the final polish was established with a composite finishing system (Astropol®) (Figures 16 through 18).

Conclusion

Indirect, metal-free composite restorations such as Sinfony™ may provide viable options for conservative restorative procedures. Additionally, enhanced physical properties increase wear and stain resistance compared to earlier generations of indirect composite restorative materials.

For clinicians seeking an indirect composite material for a variety of indications, Sinfony™ offers high plaque resistance, superior esthetics, low water absorption, and a low modulus of elasticity. Further, the material provides excellent polishability and long-term durability.

Disclosure/Acknowledgment

Dr. Hornbrook is a consultant to 3M ESPE. He would like to thank David Grin, CDT, at Lone Mountain Dental Studio, St. George, Utah.

References

Achieving Clinical and Functional Success When Fabricating a Microhybrid Composite Inlay

Learning Objectives

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

• discuss how to properly color map a tooth.
• describe how to properly evaluate tooth shade.
• list the instruments needed and the steps involved in fabricating microhybrid restorations.

Abstract

Indirect composite resins have been used in dentistry for many years, and they continue to evolve and improve. When prescribed appropriately and fabricated properly, indirect composite resin restorations become a successful treatment option in modern dentistry. This article details the tasks involved in fabricating a microhybrid composite inlay with Sinfony™ (3M ESPE) and provides recommendations to ensure clinical, functional, and esthetic success.

Shade Evaluation

The shade should be taken before the teeth have dehydrated or have been prepared. The shade of the buccal surface of the teeth should be evaluated. Many clinicians, in their haste to begin the preparation procedure, overlook the critical nature of when to evaluate shade. First, the value of the remaining dentition should be determined. Value is defined as the amount of reflection present; thus, a highly reflective dentition would appear bright or high-value. A dark or dingy dentition is low-value. This evaluation should take no more than a few seconds. If the clinician is unable to determine the value, then it is described as medium. Many evaluators confuse value with chroma, or amount of color.

The value should be determined before ever picking up a shade guide. Turn the operatory light off during this and the next two steps. Now, the hue (color) is determined. Teeth tend to fall into five basic hues: white, yellow, orange, gray, and brown. Again, before ever handling the shade guide, the hue should be chosen. Most teeth fall into the yellow color family. After the hue has been selected, the amount of color—chroma—can be determined. Note that the shade guide can be used and the tabs compared only with that particular color family to avoid confusion. The shade tab that most closely represents the chroma should be selected. If a situation arises where the question of color saturation is difficult, err toward more chroma. A restoration with more chroma blends more naturally with remaining dentition. After the value, hue, and chroma have been determined, the operator light can be turned back on. The remaining steps refine the evaluation process. These areas should be evaluated by examining the occlusal surfaces of the teeth.

The occlusal fossae of the dentition are examined next. A hue will often emanate through this area. This is the dentin peaking through the thinner areas of enamel. Often, this area will appear yellow–orange. If all of the remaining dentition has been restored, the clinician can approximate the occlusal fossae halo color by referring to the hue family discussed previously.

After examining the occlusal fossae of the dentition, the amount of pit-and-fissure characterization is determined. Light would be found in the pits only. Medium is described as stain being present in the pits as well as in the developmental anatomy. Dark would describe the pits, developmental anatomy, and some—but not all—of the supplemental anatomy. This descrip-

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tion must be shared with the technician to eliminate ambiguity. Finally, the amount of hypocalcified surface is determined. Again, light, medium, and dark designations will suffice. A word of caution: If the shades were evaluated when the teeth were dehydrated, the amount of hypocalcification would appear falsely heavy. With a little practice, this entire procedure can be performed in less than 60 seconds.

Tooth Preparation

Tooth preparation for a Sinfony™ restoration is the same as with other composite or all-porcelain inlay/onlays. Overall, 1.5 mm to 2 mm of reduction is required. A 1-mm to 1.5-mm width at the shoulder margin is mandatory. All sharp line angles should be eliminated to reduce stresses. Inlays should have 15 degrees of divergence, and gross undercuts should be eliminated. An esthetic margin zone can be created at the buccal surface if that cusp has been hooded by extending a slight chamfer down off the shoulder. Whenever possible, the cervical margin should remain supragingival to facilitate bonding.

Impression

A quality polyvinyl siloxane impression is required for accurate fabrication. The impression should be accurate and free from voids and distortion. Margins should be clear and definable. Tray adhesive must be used. The laboratory technician will pour the impression several times during the fabrication process.

Model and Die

Models should be poured using a neutral-colored quality die stone following the manufacturer’s instructions. Colored die stones inhibit the technician’s ability to properly formulate shades because the underlying hue of the stone combines with the dentin and alters the perception of color. The removable die should be sealed using a superthin cyanoacrylate glue (Figure 1). Clear blockout material should be used for the die undercuts (Figures 2 and 3). Models are mounted, equilibrated, and ready for restoration fabrication.
Instrumentation

The author prefers to limit instrumentation to as few instruments as possible. The following instruments are recommended: (1) PTC #4 waxing instrument for adding composite material; (2) 0.008-inch endodontic file (K-file) for placing pit stain; and (3) a small brush for characterizing. Excessive instrumentation slows the process and is simply not necessary to create beautiful restorations.2

Creating the Restoration

The separator is applied to the master die to facilitate release (Figure 4) and allowed to dry. The prescription from the dentist is carefully reviewed. The appropriate dentin material is applied to the floor and interproximal areas of the die using the PTC #4 instrument (Figure 5). This material is precured for 10 seconds. Next, an orange modifier is applied to the occlusal fossae area (Figure 6). This application is precured for 10 seconds. When that layer is cured, the translucent material (Sinfony™ T1) is applied to the axial walls up to the cavosurface margins. In addition, a thin bead line is run across the marginal ridge areas, and the onlay cusp areas are augmented. This application should be kept 0.5 mm out of occlusal contact (Figure 7) and precured for 10 seconds. The enamel material (in this case Sinfony™ E3) is applied directly over the material previously applied and a fishmouth border is created (Figure 8). The buildup should still be 0.5 mm out of occlusal contact (Figure 9). Next, the occlusal convexities can be added and precured incrementally and one at a time to maintain separation/delineation (Figures 10 and 11).

Finishing

Before final curing, the restoration is rough-finished. The occlusal interferences are checked first (Figure 12). Premature contacts are eliminated using a high-speed 1D diamond bur and then the anatomy is defined using a high-speed mosquito bur (Figure 13). The anatomy is softened and accentuated using the 1D diamond bur (Figure 14). The anatomy can be further detailed
using a low-speed, round-end, diamond bur (Figure 15). All remaining proximal and axial contours are adjusted with a silicone wheel. All surfaces are cleaned with a blast of compressed air, and a thin coat of Sinfony™ Activator liquid is applied (Note: do not precure). This will reduce the surface tension and facilitate characterization (Figure 16). Brown modifier is applied to the fissures using the 0.008-inch endodontic file (Figure 17). Finally, white modifiers are applied to accentuate convexities (Figure 18). The restoration is removed from the die (Figure 19), and the margins are inspected for overextensions. The restoration is placed in the curing unit and programmed according to the manufacturer’s instructions.

**Polishing**

After the restoration has been polymerized, it should be placed back on the die and rough-finished using a Fuzzy Wheel (Figure 20). External surfaces are polished using Diashine Fine and a soft-bristle brush (Figure 21). A shiny luster should appear almost immediately. The restoration, as well as the die, should now be steam cleaned. The restoration is removed using a piece of clear utility wax. The restoration is steam cleaned again, and the fit is checked again on a separate die to ensure accurate fit and marginal integrity (Figure 22). The restoration is then seated on a solid model to refine the path of insertion and proximal contact (Figure 23) and returned to the master die for final verification. The internal aspects of the restoration are lightly air abraded using Rocetec™.

**Conclusion**

When prescribed appropriately and fabricated properly, indirect composite resin restorations are a very successful treatment option. By following sound protocol for color mapping, preparation design, impression making, and creation of models and dies, esthetic and functional indirect composite inlays can be successfully and predictably fabricated.

**Disclosure**

Mr. Grin is a consultant to 3M ESPE.

**References**

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**Quiz**

**CE 1 Dr. Hornbrook**

1. In transverse impact tests, Sinfony™ demonstrated an impact strength of:
   a. 0.75 mJ/mm.
   b. 1.75 mJ/mm.
   c. 75 mJ/mm.
   d. 750 mJ/mm.

2. In a three-media-wear machine, Sinfony™ showed significantly less abrasion than other materials at:
   a. 1.75 µm.
   b. 17.5 µm.
   c. 175 µm.
   d. 1,750 µm.

3. How many degrees of taper were established in the preparation walls?
   a. 1 to 3
   b. 3 to 5
   c. 5 to 7
   d. 7 to 9

4. What type of margin was placed at the proximal gingival margin?
   a. butt-joint
   b. chamfer
   c. feather
   d. beveled

5. Provisionalization was achieved using:
   a. a copper inlay.
   b. an aluminum inlay.
   c. a BIS-Acryl provisional material.
   d. a composite provisional material.

6. A silane coupling agent was applied to the internal surface of the inlay and allowed to sit undisturbed for:
   a. 1 minute.
   b. 2 minutes.
   c. 5 minutes.
   d. 20 minutes.

7. Moisture- and oil-free air was used to evaporate any excess:
   a. saliva.
   b. water.

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**CE 2 Mr. Grin**

8. After how long was an explorer used to carefully peel away the excess cement from the margins?
   a. 1 minute
   b. 2 minutes
   c. 3 minutes
   d. 4 minutes

9. An oxygen inhibitor was placed on all margins to eliminate the formation of:
   a. a bubble zone.
   b. an oxygen inhibition layer.
   c. cross-link polymerization.
   d. parallel polymerization.

10. Any rough margins were smoothed using:
    a. 15-µm finishing diamond.
    b. 30-µm finishing diamond.
    c. 15-µm finishing carbide.
    d. 30-µm finishing carbide.

11. Matching remaining tooth structure when designing and fabricating indirect composite restorations is dependent on:
    a. proper tooth preparation.
    b. shade evaluation and communication.
    c. restoration fabrication.
    d. all of the above

12. What is defined as the amount of reflection present?
    a. value
    b. reflectivity
    c. hue
    d. chroma

13. Teeth tend to fall into how many basic hues?
    a. 4
    b. 5
    c. 6
    d. 7

14. Most teeth fall into which family of color?
    a. white
    b. yellow
    c. orange
    d. gray

15. If a situation arises where the question of color saturation is difficult, err toward more:
    a. hue.
    b. value.
    c. chroma.
    d. tint.

16. Dark would be used to describe:
    a. pits.
    b. developmental anatomy.
    c. some, but not all, of the supplemental anatomy.
    d. all of the above

17. Colored die stones inhibit the technician's ability to:
    a. use colored wax.
    b. use clear wax.
    c. properly formulate shades.
    d. see the margins.

18. For instrumentation, which of the following instruments is recommended?
    a. a PTC #4 waxing instrument
    b. an 0.008-inch endodontic file
    c. a small brush
    d. all of the above

19. What modifiers are applied to accentuate convexities?
    a. white
    b. yellow
    c. orange
    d. gray

20. During polishing, the restoration is removed using a(an):
    a. explorer.
    b. piece of clear utility wax.
    c. spoon.
    d. floss.
SINFONY™
INDIRECT LAB COMPOSITE

The indirect restorative material that has earned first chair

First Chair: The honored position within the orchestra for its most talented performer. Among composite materials, Sinfony™ Indirect Lab Composite has earned the right to be First Chair. Luster, strength, aesthetics, color stability, polishability, superior handling—Sinfony indirect lab composite always gives a virtuoso performance. Excellent for inlays/onlays, veneers and full crowns, Sinfony indirect lab composite has been proven in tests to be as strong or stronger than other popular brands. Sinfony indirect lab composite restorations have been shown to maintain luster well after placement, and patient acceptance after one year is very high. In other words, Sinfony indirect lab composite earns a standing ovation time after time. That should be music to your ears. For clinical references or more information, call 1-800-216-9502 or visit our Web site: www.3MESPE.com.