An Indirect Matrix Technique for Fabrication of Fiber-Reinforced Direct Bonded Anterior Bridges

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Abstract: **This article discusses the use of a fiber-reinforced direct-bonded resin bridge, which provides lower treatment costs and requires less time than more conventional restorative materials. However, a disadvantage is the short lifespan of the prosthesis. This article describes a case report in which this technique is applied.**

In the past 15 years, fiber reinforcement has allowed clinicians and laboratory technicians to increase the physical properties of the restorative materials being used. Materials such as composite resins and acrylics, with the incorporation of fiber reinforcement, can provide more durable restorations.[1] Beginning in 1990, various types of fiber-reinforcement materials were introduced, including carbon, glass, Kevlar® (E.I. du Pont de Nemours and Company, www2.dupont.com), and ultra-high molecular weight polyethylene (UHMWPE).[2-5] Although clinical success has been mixed regarding the different materials, the most popular fiber types are glass and UHMWPE.[6-12]

UHMWPE is a linear homopolymer of ethylene with a very low coefficient of friction with high wear resistance and high-impact strength. Plasma treatment of the UHMWPE (Ribbond® THM, Ribbond, www.ribbond.com; Connect™, Kerr Corp, www.kerrdental.com) allows chemical adhesion with composite resin, and the material typically is woven into a ribbon.[6,11] Ribbond THM is woven in a lockstitch leno weave, whereby the fibers are maintained in their orientation and the ribbon does not unravel when cut. The consistent fabric orientation allows for more reliable reinforcement when splinting teeth or fabricating a fiber-reinforced fixed prosthesis. In addition, the fibers embedded in the resin are able to stop crack propagation when a fracture occurs in the overlaying resin.[11,13,14] Adaptability to the surface being splinted or acting as fixed partial abutments is important, and the flexibility of the UHMWPE ribbon is a result of the lack of fiber memory as it is being adapted. When the fiber cannot be closely adapted to the teeth, the composite resin is thicker, decreasing the durability of the fiber-reinforced composite.[12,15,16]

When failure occurs in UHMWPE fiber-reinforced composite, a crack progresses through the composite and is stopped when the fiber is encountered. This is evidenced in specimens for which failure was not caused by rupture, rather, a bending and deflection of the material.[14] The mode of bending demonstrates the high levels of strain absorbed and its greater toughness. The leno weave of Ribbond THM also allows the embedded ribbon to maintain its integrity, minimizing shifting of the fabric within the composite. This provides multidirectional reinforcement of the composite resin, stopping the progression of cracks.[10,16]

When a single anterior tooth is lost to trauma, periodontal disease, endodontic issues, or nonrestorability, there may be an urgency to replace the tooth in a single visit. Placement of a direct-bonded fiber-reinforced composite fixed prosthesis may meet the patient's time constraints and financial limitations. This can serve as a long-term temporary restoration or an interim restoration while an implant osseointegrates. The pontic of this prosthesis can be fabricated from the coronal portion of the patient's extracted tooth, a denture tooth, or composite resin.[17,18] Studies have demonstrated that UHMWPE leno weave-reinforced fixed prosthesis contributed to significant composite reinforcement.[14,19,20] With regard to longevity, these fixed fiber-reinforced restorations have demonstrated clinical service of 5 to 10 years.[21]

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FIXED FIBER-REINFORCED COMPOSITE PROSTHESIS

Many dentists place direct-bonded bridges to replace mandibular anterior teeth or to splint teeth together, using a fiber embedded in resin for reinforcement.[22-28] The authors believe there are two significant logistical problems in using fiber reinforcement: transporting the fibers from the tray to the teeth and correctly positioning the fibers on the teeth. This article details a new technique to eliminate stress when using fibers for reinforcement.

CASE REPORT

A 48-year-old man presented after the loss of a lower anterior tooth. His medical history included two recent bouts of Lyme disease. Specialists in Lyme disease were consulted and could not explain why the patient was not returning to normal health despite treatment. The authors are unsure if the medical history had an impact on the dental issue being treated, and this was supported by the consultation with the Lyme disease specialists. A full-mouth series of radiographs revealed a large chronic periapical area around tooth No. 24, which had previous endodontic treatment and a crown.

The patient was referred to an endodontist for evaluation for possible endodontic re-treatment, and the tooth was determined to be hopeless. The patient then was referred to an oral surgeon for extraction. Following that procedure, the patient was referred for restorative treatment (Figure 1). Replacement options for the missing tooth were discussed with the patient who indicated he did not wish to pursue an implant and expressed concern regarding preparation of the adjacent teeth for a conventional fixed bridge. No other teeth were missing from the mandibular arch. Because the adjacent teeth were free of caries or restorative material, a fiber-reinforced resin-bonded bridge was offered as a prosthetic solution. Placement of an implant was discussed. However, because of financial considerations, this was not within the patient's scope of treatment. An alternative would have been a conventional fixed porcelain-fused-to-metal bridge, but this would have required preparation of the virgin adjacent teeth. As the patient was not missing any other teeth in the arch, a removable partial denture was not a good option.

Impressions were made for fabrication of study models, using alginate and stock impression trays. The models were poured in hard-die stone and mounted on an articulator. Next, composite resin (Filtek™ Supreme Plus, 3M ESPE, www.3mespe.com) was placed into the edentulous space on the model to create a roughly shaped pontic (Figure 2). Incorporation of fine details in the pontic was not necessary at this stage because the purpose of the material on the model was to create space for the polyvinyl siloxane (PVS) matrix that would be fabricated. Then, more resin was added on the lingual of the teeth to create retainer wings on the teeth that would be splinted with the fiber-reinforced restoration

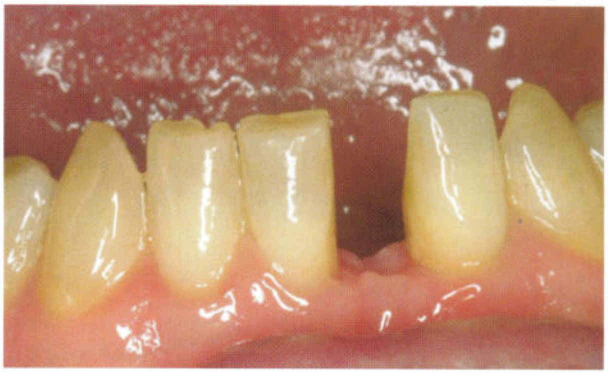

Figure 1 Patient at presentation, which followed extraction of the lower left central incisor.

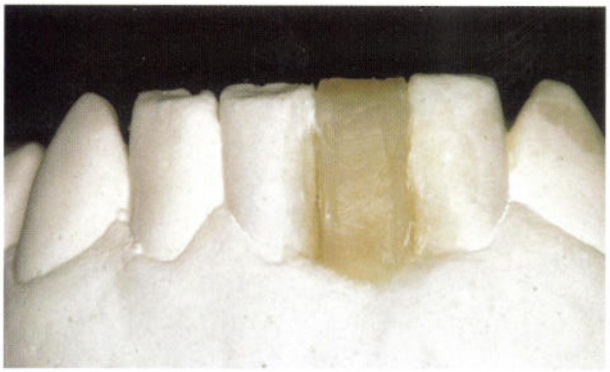

Figure 2 Buccal view of the model, showing the pontic wax-up.

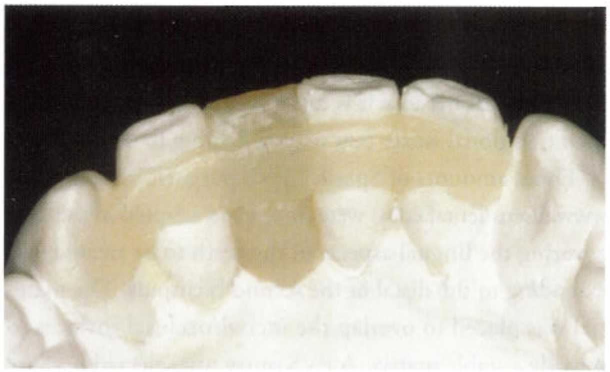

Figure 3 Lingual view of the model after wax-up of the pontic and lingual retainer wings.

Figure 4 PVS matrix positioned on the model of the wax-up.

Figure 5 Uncured composite and Ribbond THM placed into the PVS matrix ready for insertion intraorally.

Figure 6 Labial view of the lingual aspect of the pontic after removal of the matrix intraorally.

Figure 7 Lingual view showing the bonded Ribbond THM-reinforced retainer wings and lingual shell of the pontic.

(Figure 3). The authors suggest using composite in the wax-up of the cast because it is easier to manipulate and shape than traditional waxes that require heating to manipulate.

Equal amounts of Splash!® PVS putty (Discus Dental, www.discusdental.com) were mixed and adapted to the cast, covering the lingual aspects of the teeth to be treated and extending to the distal of the second bicuspids. The material was placed to overlap the incisal/occlusal surfaces to provide a stable matrix. A PVS putty was selected because of its ability to adapt to the cast and accurately record both the teeth and wax-up. A scalpel was used to trim the PVS matrix on the facial aspect to cover only the incisal edges and did not obscure the pontic area (Figure 4).

The matrix was removed from the model, and a thin layer of Filtek Supreme Plus, enamel shade B2, was placed into the matrix in the position of the retainer wings and the lingual aspect of the pontic, creating a very thin shell in these areas. The composite was left uncured. Care must be taken to avoid placing too much material in the matrix because excess material can prevent full placement of the matrix intraorally. A piece of dental floss was used to measure the length of the retainer between the distal of tooth No. 22 and the distal of tooth No. 26 on the model. Two pieces of Ribbond THM in a 3-mm width were cut to match the length of the floss. The authors recommend using floss to measure the length to eliminate contamination of the Ribbond THM before placing resin on the fibers.

The Ribbond THM strips were coated in an unfilled resin (Heliobond, Ivoclar Vivadent, Inc, www.ivoclarvivadent.us). Excess resin was blotted from the impregnated Ribbond strip using a paper napkin, leaving the strips lightly wetted with resin. The resin-impregnated Ribbond THM strips were placed onto the Filtek Supreme Plus that was placed in the matrix. A length of Filtek Supreme Plus resin was rolled with fingers against a clean, hard surface to create a very thin cylinder of resin, which then was placed over the Ribbond THM in the matrix to create a sandwich of resin, fiber, and resin (Figure 5). The matrix was placed under a light-proof cover to prevent premature setting from the operatory lights.

A rubber dam was placed intraorally using a split-dam technique.[29] The lingual aspects of the anterior teeth were microetched using 50-µm alumina oxide (Danville Materials, www.danvillematerials.com), then rinsed and dried. Grit blasting creates a macro-roughened surface, increasing the surface area, which then would be acid etched to provide a better surface for bonding adhesion. Next, the teeth were acid etched with a 37% phosphoric acid gel for 30 secs, rinsed, and dried. A filled dental adhesive resin OptiBond® Solo Plus™ (Kerr Corp) was applied to the etched surfaces and light cured. The matrix was carried to the mouth and positioned on the teeth, with light pressure applied to the lingual aspect of the matrix to ensure adaption of the fiber-reinforced resin to the lingual of the teeth. Light curing was accomplished through the facial aspect of teeth involved in the retainer for 60 secs per tooth. After curing, the matrix was removed and additional light curing was performed lingually for 60 secs per tooth. The result at this stage is a thin shell representing the fiber-reinforced lingual aspect of the pontic and the completed fiber-reinforced wings (Figure 6 and Figure 7).

The authors believe a major advantage of the matrix is that the incisal edge of the pontic is formed completely inside the matrix and virtually no occlusal adjustment is needed. Another advantage is that the lingual fiber-reinforced material is positioned under pressure over the entire retainer so voids or adaptation issues are eliminated.

Using a mixture of shades A2 and C2 composites, the pontic was built in layers to complete the contours and bulk of the pontic. The bulk of the pontic was fabricated with Renamel® MicroHybrid (Cosmedent, Inc, www.cosmedent.com) for strength. Renamel® Microfill (Cosmedent, Inc) was overlaid on the entire labial surface of the pontic because of its ability to be polished to a glass-smooth finish that could be retained long term. The rubber dam was removed, and finishing and polishing were accomplished with green rubber cups (Ivoclar Vivadent, Inc) (Figure 8 and Figure 9). A finishing strip with a fine grit (FlexiStrips, Cosmedent, Inc) was used under the pontic to provide a smooth surface and assist in hygiene maintenance. Finishing under the pontic after bridge fabrication can be difficult, and fabrication of a thin shell on the model may result in a smoother surface.

CONCLUSION

All treatment options have advantages and disadvantages. Among the advantages of the use of a fiber-reinforced direct-bonded resin bridge are lower treatment costs and less time than more conventional methods. In addition, the technique described can be considered a reversible procedure because the abutment teeth were not prepared. The disadvantage of this method is the potential for a short lifespan of the prosthesis. However, one of the authors has patients with prostheses similar to the one described that have remained in service for up to 15 years with no failures to the fiber reinforcements. These results are supported by Strassler, who reported the lifespan of these prostheses to be as long as 10 years.[1] With properly adjusted occlusion, including good anterior guidance and avoidance of mastication into hard food such as whole apples, these prostheses can offer a number of years of functional use without the need to replace or fix them. Placement of fiber reinforcement on the lingual aspects of teeth can be a clinical challenge. Because the entire retainer cannot be cured simultaneously, clinicians first need to adapt the resin-covered fiber reinforcement and then cure one end of the retainer, working their way to the opposite end. This can

Figure 8 Lingual view of the finished fiber-reinforced resin-bonded bridge.

Figure 9 Labial view of the completed fiber-reinforced resin-bonded bridge.

lead to voids or maladaptation of the material. The matrix, as outlined in the presented technique, permits adaptation of the entire lingual aspect at one time, ensuring good adaptation and elimination of voids.

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