

Chairside Replacement of Posterior Teeth Using a Prefabricated Fiber-Reinforced Resin Composite Framework Technique: A Case Report

JONATHAN C. MEIERS, DMD, MS*
REZA B. KAZEMI, DMD†

ABSTRACT

The fixed replacement of a single posterior missing tooth for those patients who cannot have either implants or conventional laboratory-generated fixed prostheses has always been a challenge to clinicians. The development of fiber-reinforced composites (FRCs) has opened up new possibilities of chairside treatment options to manage these types of clinical situations. Techniques using FRCs as frameworks with traditional restorative resin composites as veneering materials can provide chairside fixed prostheses that are esthetic and potentially durable, with minimal abutment tooth loss.

A clinical case is presented that will illustrate a novel concept for tooth replacement—the use of an FRC prefabricated framework—to allow for a single visit, chairside replacement of a missing molar. The assembly of the framework and the clinical steps used in the framework placement and pontic fabrication are shown in detail.

CLINICAL SIGNIFICANCE

The combination of FRC technology and adhesive techniques can provide minimally invasive and cost-effective treatment options for the chairside replacement of missing posterior teeth.

(*J Esthet Restor Dent* 17:335–342, 2005)

The fixed replacement of a single posterior tooth when an implant and a conventional or Maryland bridge type of laboratory-generated prosthesis is not possible can be a considerable challenge. This situation can arise for reasons related to health, abutment tooth prognosis, age, and financial or time limitations. The solution to this treatment dilemma requires that the clinician use a chairside approach to attach

a preformed or direct fabricated pontic to the teeth adjacent to the edentulous space. In the anterior, this can be managed by techniques that use adhesives and a resin composite or fiber reinforcement and a resin composite to attach a pontic formed from a denture tooth, an extracted natural tooth crown, or a resin composite.^{1–10} There is little information in the literature regarding using the same techniques for

posterior tooth replacement. Reported techniques usually involve the use of a denture tooth or a preformed resin composite pontic button supported by fiber-reinforced resin composite.^{6,13} These approaches can achieve the goal of providing a tooth replacement but involve the use of either dissimilar materials in their fabrication or a long, involved clinical fabrication process that can lead to unpredictable results.

*Professor, chair, Division of Operative Dentistry, Department of Oral Rehabilitation, Biomaterials & Skeletal Development, University of Connecticut School of Dental Medicine, Farmington, CT, USA

†Associate professor, course director, Pre-clinical Operative, Department of Oral Rehabilitation, Biomaterials & Skeletal Development, University of Connecticut School of Dental Medicine, Farmington, CT, USA

The following case illustrates the use of a prefabricated fiber-reinforced resin composite framework technique to replace a missing molar. The framework fabrication, theory, and a clinical technique are described in detail.

CASE PRESENTATION

Framework Fabrication

The framework is fabricated using a resin preimpregnated fiber-reinforced composite (FRC; everStick, Stick Tech, Ltd, Turku, Finland). This material features unidirectional glass fibers contained in a nonpolymerized polymethyl methacrylate (PMMA)/bisphenol A glycidyl methacrylate matrix with a PMMA capsule that prevents the glass fibers from fraying on manipulation (Figure 1). This particular composition provides a user-friendly resin preimpregnated FRC for the clinician to manipulate. The FRC is cut into segments that will be used for the wings and to shape the pontic substructure support (Figure 2). The long segment is used for the wing attachment, and the smaller segments are used to shape the pontic support. Machined aluminum split molds with various-shaped wells are used to help create the framework (Figure 3). These are not commercially available and were manufactured to specifications in a machine shop. We have also used putty split molds fashioned along the same design as a template for framework fabrication. The lower portion of the aluminum split mold

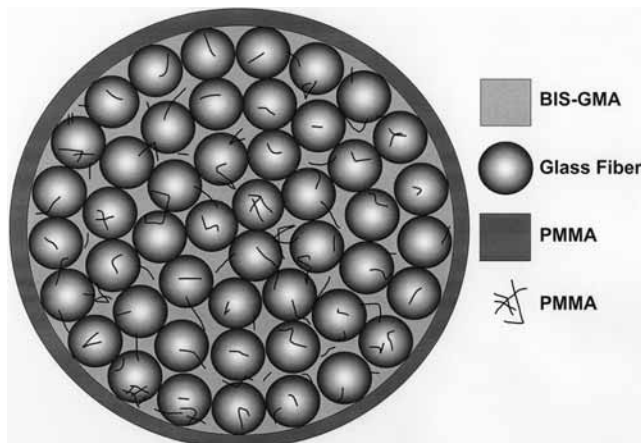


Figure 1. Cross-section of everStick fiber-reinforced composite showing the various components. BIS-GMA = bisphenol A glycidyl methacrylate; PMMA = polymethyl methacrylate.



Figure 2. Segments of everStick resin preimpregnated fiber-reinforced composite that are used in the fabrication of a chair-side bridge. Smaller segments are used for shaping the pontic support, and the longer length is used for the wing attachment.

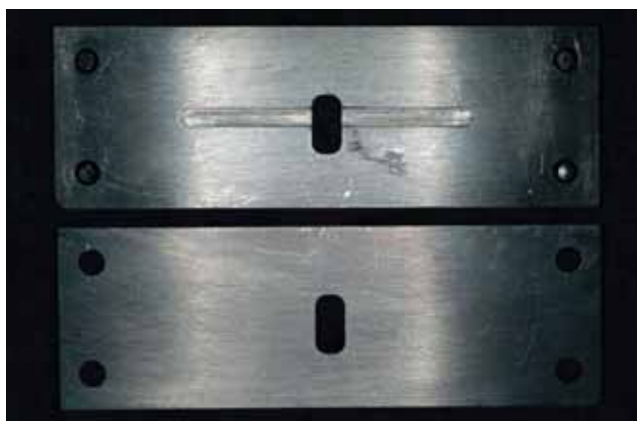


Figure 3. Aluminum molds that are used during the assembly of the fiber-reinforced composite segments. The top split mold holds wells for the pontic and the wings to be positioned, and the lower split mold provides the cover to protect the wings from being polymerized while the pontic segments are being added for their eventual shape.

is designed to have recessed areas to help form the wing and pontic substructure. The upper section of the mold allows for light curing of the pontic substructure but not the wing segments (Figures 3–6). The wing segment is placed first into the mold (see Figure 4), and the pontic segments are added to this with dual-curing resin composite luting cement to help hold them in place on the wing (see Figure 5). This is light cured for only 2 to 3 seconds to initially set the luting resin/pontic FRC segments (see Figure 6).

This short exposure time is to avoid any additional curing of the connector areas next to the pontic to prevent them from becoming too stiff to allow them to mold to the proximal contours of the abutment teeth. The glass fibers conduct light within the wings even though these are covered with the mold. The wing segments are wrapped in aluminum foil (Figure 7) to prevent light from reaching and polymerizing them during chairside manipulation of the framework prior to insertion in the mouth. This allows

for the wings to stay flexible to adapt to tooth surface contours when the framework is placed on the abutment teeth. The completed posterior (molar/premolar) prefabricated FRC bridge framework is shown in Figures 8 and 9. The wings will be used to attach the framework to the abutment teeth, and the pontic substructure will provide support and strength for the resin composite veneer. The prefabricated FRC bridge assembly is placed into a foil pouch for storage until it is needed (Figure 10).



Figure 4. Strips of fiber-reinforced composite are being added to the lower mold.

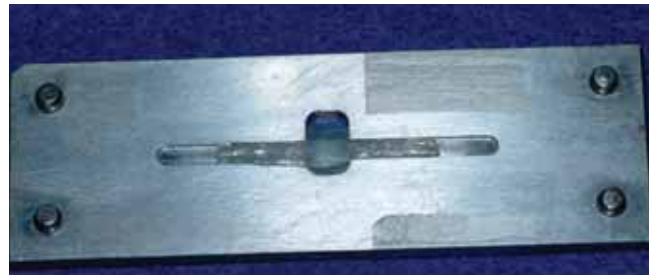


Figure 5. Mold with the strips for the pontic and wings prior to placing the upper mold before a light-curing step.



Figure 6. The pontic segment being polymerized while the wings are protected from the light with the upper mold section.



Figure 7. After the pontic framework is shaped and polymerized, foil is used to wrap the nonpolymerized wings to protect them from premature polymerization. The wings are kept nonpolymerized to maximize their polymerization with the luting resin and for pliability to help adapt them intimately to the contours of the abutment teeth.

Basic Theory of Technique

The basic clinical aspects of this technique are illustrated with Figures 11 to 14. The prefabricated FRC framework is positioned over

the abutment teeth and edentulous space—by holding the pontic substructure with a curved hemostat—so that the pontic substructure is centered within the space (see Fig-

ures 11 and 12). The wings are trimmed with a pair of ceramic scissors to fit within the proximal slot preparations that will be placed in the abutment teeth (see Figure 12).



Figure 8. Side view of the prefabricated fiber-reinforced composite (FRC) molar framework showing the occlusal gingival FRC support for the particulate resin composite veneer, which will create the pontic.



Figure 9. Occlusal view of the finished prefabricated fiber-reinforced composite molar framework showing the buccolingual support for the particulate resin composite veneer.

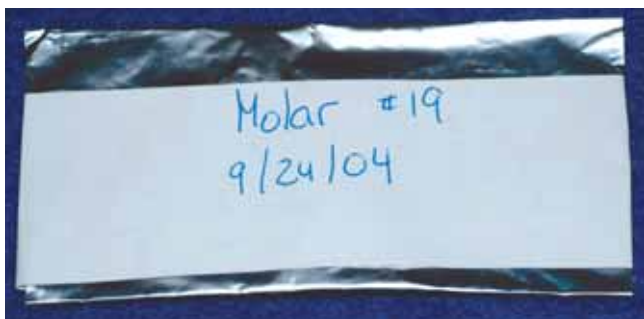


Figure 10. The prefabricated fiber-reinforced composite framework assembly is packaged in a foil pouch while awaiting placement and refrigerated to extend the shelf life of the material.

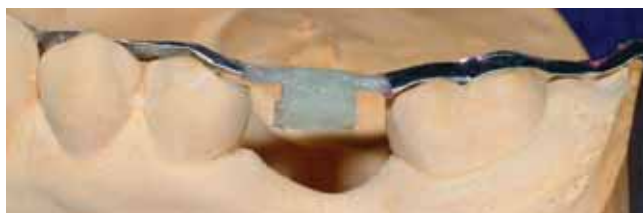


Figure 11. Model displaying the positioning of the prefabricated fiber-reinforced composite framework within the edentulous space, with the wings on the occlusal surfaces of the abutment teeth. In the clinical situation, the framework would be approximately 1.5 to 2 mm below the occlusal plane by being placed into proximal slots on the abutment teeth. This would allow for an adequate thickness of the particulate resin composite veneer to develop proper anatomic form.



Figure 12. Prefabricated fiber-reinforced composite framework on the model showing the wings sized for placement into proximal slots and the positioning of the pontic support within the edentulous space.

The relationships of the framework wings within the proximal slots of the abutment teeth and of the pontic substructure to the overlaying resin composite veneer are illustrated in Figures 13 and 14. The FRC pontic support is designed to maximize the volume of the FRC and help provide support for the buccal, lingual, and occlusal extent of the resin composite veneer. This minimizes the thickness of the resin composite veneer and the extent of unsupported resin composite to reduce the potential for bulk fracture of the resin composite away from the FRC. This type of design has been shown in a previous clinical trial of FRC three-unit bridges to virtually eliminate pontic veneer fractures of the resin composite veneer away from the FRC.¹²

Chairside Framework Delivery and Pontic Fabrication

The patient presents with a missing first left mandibular molar (Figure 15A and B). The eventual treatment plan is to restore the edentulous

space with an implant crown, but because of financial issues this will not be feasible for a number of years. To maintain the space and to provide function, a prefabricated FRC framework bridge is presented and accepted as a transitional treatment until the more definitive solution can be provided. The second molar has an existing proximal resin composite restoration, and the second premolar has no restorations.

The area is isolated with a rubber dam, and the proximal slot composite restoration is removed from the mesial aspect of the molar. A proximal slot preparation is made on the distal aspect of the premolar (Figure 15C). This will serve as a receptacle or bed for the wings of the FRC framework. The framework is tried in to verify the correctness of the length of the wings and the location of the pontic substructure using either a cotton forceps or a hemostat holding the pontic substructure. The pontic substructure needs to be positioned

so that it is located centrally in the edentulous space, mesially, distally, and buccolingually. The occlusal plane should be low enough to allow space for the resin composite veneer on the occlusal surface and to form the ridge of the pontic on the gingival aspect. If any adjustments need to be made to the pontic substructure, they are done at this time using a high-speed carbide finishing bur.

The wings are then inserted and cured into the prepared slots one at a time using the following procedure. The slot preparations are etched with phosphoric acid and rinsed, and an adhesive is applied. A thin layer of hybrid resin composite is placed (but not visible light cured at this time) on the pulpal floor of the abutment tooth to which the first wing is to be attached. This acts as a bed to help maintain the FRC wing in the slot preparation during its initial placement. The foil is removed from one of the nonpolymerized wings (in

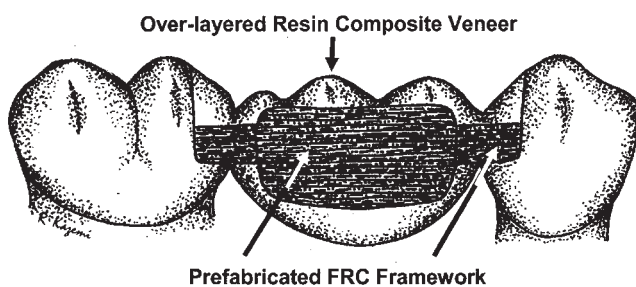


Figure 13. Lateral view of a bonded prefabricated fiber-reinforced composite (FRC) chairside bridge showing the wings inserted into the prepared proximal slots in the abutment teeth and the relationship of the FRC framework support with the resin composite veneer.

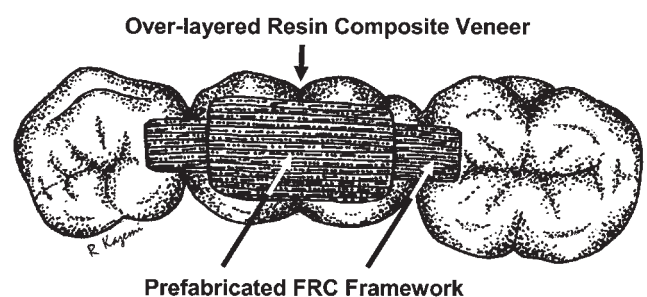


Figure 14. Occlusal view of a prefabricated fiber-reinforced composite bridge showing the relationship of the framework with the resin composite veneer.



Figure 15. A, Occlusal view of a missing first molar. The second premolar has no restorations, but the second molar has a conservative occlusal/proximal resin composite. B, Proximal view of missing first molar. C, Conservative box preparations are prepared on the proximal aspects of the abutment teeth. Dimensions are approximately 1.5 to 2 mm long, 1.5 to 2 mm wide, and 2 mm deep. D, Framework being placed into the abutment tooth boxes. The framework is held in the desired position within the edentulous space by the pontic support with a hemostat. One foil-free wing is placed into the box that is lined with a resin composite bed and is visible light cured in place. E, Occlusal view of the framework in place with the wing luted into the premolar box. The foil is left on the other wing to prevent premature polymerization while the first wing is placed. F, The second wing is placed into the molar box using a condenser to push it into the resin composite bed. G, Proximal view of the luted fiber-reinforced composite framework. H, The tissue side of the pontic is formed using the rubber dam as a matrix. I, The pontic is built using a particulate resin composite to shape the buccal, occlusal, and lingual contours. J, The finished chairside bridge—occlusal view. K, The finished chairside bridge—lingual view. L, The finished chairside bridge in occlusion—buccal view.

this case for the anterior abutment, the premolar), and the framework is carried to the teeth and positioned with either a cotton forceps or a hemostat holding the pontic (Figure 15D and E). The wing is compressed into the composite bed of the slot preparation using a condenser and is visible light cured. This initiates the attachment of the framework.

The hybrid composite is then applied in a thin layer into the molar slot. The foil is removed from the nonpolymerized wing, and this wing placed into the composite bed with a condenser and is visible light polymerized (Figure 15F). The attached framework was now ready for pontic veneer placement (Figure 15G). The pontic substructure is thinly coated with a flowable composite to help wet this shape for additional layers of resin composite addition. The pontic veneer is started by creating the tissue side first, using the rubber dam as a mold to help hold and shape this surface. The composite is pressed between the gingival extent of the FRC framework and the rubber dam, creating a shape that will duplicate the ridge, with the dam providing the space to allow the area to be cleaned by floss and light cured (Figure 15H). The dam can be held down to tightly adapt to the ridge shape to allow for a ridge lap design. The remainder of the pontic shape is created with sequential additions of veneering composite to form the buccal, lingual, and occlusal surfaces (Figure 15I). The

final shape and polishing of the pontic is accomplished using carbide finishing burs or fine composite finishing diamonds, disks, and impregnated rubber points and cups. The rubber dam is removed and the occlusion checked and adjusted (Figure 15J–L).

DISCUSSION

The unique aspect of this approach is that it uses a prefabricated framework to aid in the chairside construction of the bridge. These frameworks can be made ahead of time and stored in a refrigerator for use as the situation arises. Frameworks can be made for every tooth replacement situation using just a few different molds. Although we have only used resin preimpregnated fiber-reinforced systems, nonresin preimpregnated fiber-reinforced systems, such as Ribbond (Ribbond, Seattle, WA, USA), might also be used successfully with this approach. Having a framework already formed eliminates the time and technique sensitivity of trying to construct this in the mouth. It provides the opportunity for a consistent technique and clinical result with minimal skill. Any clinician who has had experience placing direct veneers should have no trouble developing a pontic veneer that is functional and esthetic in a minimal amount of time.

The use of an external approach to place the wings of the framework (buccal or lingual application)—which would be more conservative by eliminating tooth removal—was

tried initially in developing this technique for use with posterior teeth. Unfortunately, that approach did not provide successful results for more than a year and was much more technically difficult to do than what has been demonstrated here. We have currently placed over 20 posterior bridges with remarkable success. Only one bridge has failed, with a fracture of the FRC framework at the connector area. The longest surviving bridge is now 3 years old. Although this approach should be looked at as a transitional type of treatment, it has proven that it can be remarkably durable and provide a good service to the patient. Future improvements in framework fabrication and the FRC and resin composite veneer materials could move this treatment modality into providing long-term, minimally invasive tooth replacement solutions for those patients unable to consider the more traditional form of treatments.

DISCLOSURE

The authors do not have any financial interest in the companies whose materials are discussed in this article.

REFERENCES

1. Strassler HE, Gerhardt DE. Management of restorative emergencies. *Dent Clin North Am* 1993; 37:353–365.
2. Strassler HE. Planning with diagnostic casts for success with direct composite bonding. *J Esthet Dent* 1995; 7:32–40.
3. Culy G, Tyas MJ. Direct resin-bonded fiber-reinforced anterior bridges: a clinical report. *Aust Dent J* 1998; 43:1–4.
4. Belvedere PC. Single sitting, fiber reinforced fixed bridges for the missing lateral or central incisors in adolescent patients. *Dent Clin North Am* 1998; 42:665–668.

5. Van Wijlen P. A modified technique for direct, fiber-reinforced, resin bonded bridges: clinical case reports. *J Can Dent Assoc* 2000; 66:367-371.
6. Freilich MA, Meiers JC, Duncan JP, Goldberg AJ. Fiber-reinforced composites in clinical dentistry. Chicago, IL: Quintessence, 2000.
7. Meiers JC, Freilich MA. Chairside prefabricated fiber-reinforced resin composite fixed partial dentures. *Quintessence Int* 2001; 32:99-104.
8. Turner WE. Direct fiber reinforced composite bridges, part 2. *J Cosmet Dent* 2001; 17(1):56-66.
9. Meiers JC, Kazemi RB, Freilich MA. Direct intra-oral applications of fiber-reinforced composites: the influence of FRC on particulate resin composite to enamel shear bond strengths. In: Vallittu PK, editor. *The Second International Symposium on Fiber-Reinforced Plastics in Dentistry*; 2001 Oct 13; Turku, Finland. Turku, Finland: Department of Prosthetic Dentistry and Biomaterials Research, University of Turku, Institute of Dentistry; 2002.
10. Freilich MA, Meiers JC. Fiber-reinforced composite prostheses. *Dent Clin North Am* 2004; 48:545-562.
11. Freilich MA, Meiers JC, Duncan JP, Goldberg AJ. Fiber-reinforced composites in clinical dentistry. Chicago, IL: Quintessence, 2000.
12. Freilich A, Meiers JC, Duncan JP, Eckrote KA, Goldberg AJ. Clinical evaluation of fiber-reinforced fixed bridges. *J Am Dent Assoc* 2002; 133:1524-1534.
13. Belvedere P, Turner WE. Direct fiber-reinforced composite bridges. *Dent Today* 2002; 21(6):88-93.

Reprint requests: Jonathan C. Meiers, DMD, MS, Department of Oral Rehabilitation, Biomaterials & Skeletal Development, University of Connecticut School of Dental Medicine, 263 Farmington Avenue, Farmington, CT, USA 06030-1615; e-mail: meiers@nso2.uhc.edu

©2005 BC Decker Inc

COMMENTARY

CHAIRSIDE REPLACEMENT OF POSTERIOR TEETH USING A PREFABRICATED FIBER-REINFORCED RESIN COMPOSITE FRAMEWORK TECHNIQUE: A CASE REPORT

W. Dan Sneed, DMD, MAT, MHS*

Provisional, fixed partial dentures made from direct resin composite are not unusual. However, replacing a posterior tooth is not as common as an anterior tooth, for obvious reasons of strength. These bridges can be made directly in the mouth or by a direct/indirect technique, as is illustrated in this article. The bridge can be made entirely from composite, composite combined with various pontic materials, and/or composite reinforced with some form of fiber or metal.

The approach used in this article brings to light a few interesting and useful ideas while recognizing the limits of the technique. The use of a prefabricated framework has merit and certainly would speed fabrication in the mouth. Using inlay abutments instead of lingual wings should provide the needed strength between the pontic and the abutment (allowing a greater bulk of material).^{1,2} Even though it is not as conservative, the inlay approach should also allow for better contours, easier placement, and improved patient comfort.

The authors also emphasize that the fiber framework, which supports the pontic, must be carefully designed to provide that support. Many fiber-reinforced bridges of this type fail when the large pontic mass of composite breaks from the inadequately designed framework. The framework design must provide mechanical resistance/retentive form and enough surface area to support the resin.

The authors are also correct in terming this a transitional appliance. Three to 5 years of service might be expected if the occlusion is favorable and the bridge is properly designed, constructed, and bonded.

REFERENCES

1. Song Hy, Yi YJ, Cho LR, Park DY. Effects of two preparation designs and pontic distance on bending and fracture strength of fiber-reinforced composite inlay fixed partial dentures. *J Prosthet Dent* 2003; 90:347-353.
2. Kolbeck C, Rosentritt M, Behr M, Lang R, Handel G. In vitro examination of the fracture strength of 3 different fiber-reinforced composite and 1 all-ceramic posterior inlay fixed partial denture systems. *J Prosthet Dent* 2002; 11:248-253.

*Professor and chair, Department of General Dentistry, MUSC College of Dental Medicine, Charleston, SC, USA