

Fiber-Reinforced Framework in Conjunction with Porcelain Veneers for the Esthetic Replacement of a Congenitally Missing Maxillary Lateral Incisor: A Case Study

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Clinical Relevance

Fiber reinforced composite can allow for conservative, esthetic, biocompatible and functional restoration of a missing anterior tooth in selective clinical situations.

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SUMMARY

This article presents a case of a congenitally missing right maxillary lateral incisor and the contralateral incisor with discolored composite resin restorations. The technique of fiber reinforcement in conjunction with porcelain veneers was used to provide a satisfactory outcome for the patient. The key learning points of the article are the following: proper diagnosis, treatment plan and appropriate utilization of materials are mandatory for a successful result.

INTRODUCTION

Replacement of a single tooth in the maxillary anterior region presents exacting esthetic demands.¹



Figure 1. Labial view prior to treatment.

The loss of anterior teeth may be a result of trauma or congenital aplasia. The incidence of congenitally missing teeth in the Caucasian population is between 1% and 10%. The maxillary lateral incisor ranks after third molars and mandibular second premolars in frequency of tooth agenesis.² The resulting space may be closed by orthodontics, prosthetics, or a combination of both.³ Orthodontic treatment may often not be the treatment of choice as it may not permit optimal esthetics and function.³ If a space no longer exists, it can be opened for the fabrication of an implant or a bridge. If the canines are in the lateral position, they can be reshaped *via* additive composite techniques or porcelain veneers so that they will resemble lateral incisors. Prior to making a treatment modality decision, the molar relationship and the esthetic and the functional potential should be considered. Class I occlusion will generally permit treatment of the space by maintenance or opening. If a patient has an Angle Class II malocclusion and exhibits no crowding in the mandible, the molar relationship will be Class II and the premolars will be located in the canine position, and canine substitution can be used to replace the lateral incisor. If a Class I malocclusion exists with mandibular crowding sufficient to require extractions, canine substitution for the lateral incisor can again be used. Class III malocclusions contraindicate orthodontic space closure as the occlusal relationship would be worsened by the therapy.³

Also to be considered are the status of the adjacent anterior teeth; the height and width of the ridge; the condition of the buccal plate; periodontal esthetic considerations; the patient's openness to treatment alternatives; patient finances⁴; interdental spacing; treatment time; parafunctional habits⁵; predictabil-

ity of treatment alternatives; and stability of treatment outcomes. The treatment options for replacing a missing anterior tooth are implant-supported crowns, resin-bonded fixed partial dentures (RBFDPs), conventional fixed partial dentures, and removable partial dentures. Implants and adhesive bridges are preferred as they represent a more conservative treatment option compared to fixed prosthodontics. This is especially true for young patients with large pulp chambers. Implants are often not the ideal choice as tooth loss and congenitally missing teeth frequently result in insufficient bone and soft tissue for esthetic placement of the implant. Guided bone regeneration and grafts may be able to solve these problems. Osseointegration is not the only process that needs to be accomplished. Esthetic integration of the implant-supported restoration with the surrounding hard and soft tissue must also be achieved.¹ That being said, the increased cost and the intricacy of these procedures often preclude this option.³

RBFDPs require a minimal amount of abutment modification. However, bridges with metal substructure bonded to the lingual of relatively thin anterior teeth can result in a "graying phenomenon." Opaque cements may reduce this effect but the esthetic result is compromised.⁴ To overcome this problem a variety of metal-free bridges have been developed. Some have combined fiber-reinforced composite with ceramics and others are all ceramic, consisting of aluminum oxide, lithium disilicate, or zirconium oxide. This clinical report will describe an esthetic result achieved with the use of feldspathic porcelain veneers in conjunction with a highly filled composite resin (Sculpture, Pentron, Wallingford, CT, USA) that is lab processed utilizing light, heat, vacuum, and a unidirectional fiber (FibreKor®, Pentron).

CASE REPORT

A 28-year-old female patient presented at the Advanced Program for International Dentists in Aesthetic Dentistry at the New York University College of Dentistry. Her chief complaint was the discolored composite bonding on the maxillary left lateral incisor and the poor appearance of the existing three-unit fiber-reinforced bridge replacing the maxillary right lateral incisor. The maxillary right canine and right central incisor were the abutment teeth (Figures 1 through 3). The patient also expressed a desire to have her teeth bleached.

A comprehensive examination was conducted, including a full-mouth radiographic series, caries detection, periodontal probing, and intraoral and



Figure 2. *Left lateral view.*

extraoral soft tissue and temporomandibular joint exam. Palpation directly over the joint while the patient opened and closed the mandible and the extent of mandibular condylar movement were assessed. Findings were within normal limits and therefore were considered noncontributory. The masticatory and cervical muscles were palpated and searched for areas of tenderness or sustained contraction. The palpation was initiated with the sternocleidomastoid, trapezius, and posterior cervical muscles. The masseter at its attachments to the zygomatic arch and angle of the mandible, the temporalis, both in the temporal fossa and intra-orally along the ascending ramus of the mandible, were palpated. The medial pterygoid was palpated bimanually. The patient had a shift from centric relation (CR) to maximum intercuspation (MIP) and exhibited canine guidance with a mutually protected occlusion. Upon completion of the examination, a determination was made that the occlusion was physiologic and that the patient should be restored to a position of MIP.

Intraoral and extraoral photographs were taken in order to aid in the esthetic evaluation. Study models were obtained with Reprosil (Dentsply/Caulk, Milford, DE, USA). The Kois Dento-Facial Analyzer System (Panadent, Colton, CA, USA) was used to register and transfer the patient's occlusal plane to the PSH Panadent articulator. This enabled the transfer of the incisal edge position to the laboratory. After ascertaining CR with a leaf gauge, a CR bite was taken with Blu-Bite HP Rigid Fast Set (Henry Schein Inc, Melville, NY, USA). A bite registration was also taken in MIP with the Blu-Bite material.

Facial analysis revealed that the occlusal plane was parallel to the interpupillary line, that the midline relationship of the teeth to the face (Phil-



Figure 3. *Occlusal view of previous bridge.*

trum) was symmetric, and that the lips were also symmetrical to the face. Maxillary tooth exposure at rest was 3 mm and 1 mm in the mandibular arch (Figure 4). The patient also had a high smile line, with an incisal edge that was convex in relation to the lower lip. Upon smiling the patient exhibited 12 teeth.

The potential esthetic benefits of the recommended treatment were demonstrated to the patient using a putty stent obtained from the wax-up of the proposed treatment and Luxatemp® (DMG America, Englewood, NJ, USA) (Figure 5). The patient also expressed a desire to correct her buccal corridors and change the shape and shade of her upper canines and premolars. These comments/concerns were addressed in fabrication of the mock-up. Bleaching trays were also delivered to the patient, and 10% Opalescence bleach (Ultradent Products, South Jordan, UT, USA) was used for two weeks. The maxillary arch was bleached prior to the mandibular



Figure 4. *Incisal edge display.*



Figure 5. Wax-up.

arch. The patient was satisfied with the result of the tooth whitening, and the final treatment plan was confirmed. As institutional review board approval was not required by any of the procedures to be performed, none was requested.

A metal-free, two-component, resin-bonded bridge, the Encore Bridge®, was selected to replace the congenitally missing upper right lateral incisor and porcelain veneers on teeth 5-12. The framework consists of FibreKor, a fiber-reinforced composite that comes in three forms of fiber strips, and a 16K bar (16,000 individual fibers) that is formulated with a filled resin for increased strength. This is overlaid with Sculpture Plus composite. The resin composite is processed under heat (250°F), light, and pressure in the presence of nitrogen gas (80 psi) to improve the physical properties of the resin. The nitrogen gas excludes oxygen to reduce porosity and increase surface hardness. The lower modulus of elasticity of the framework decreases the stress on the wing/

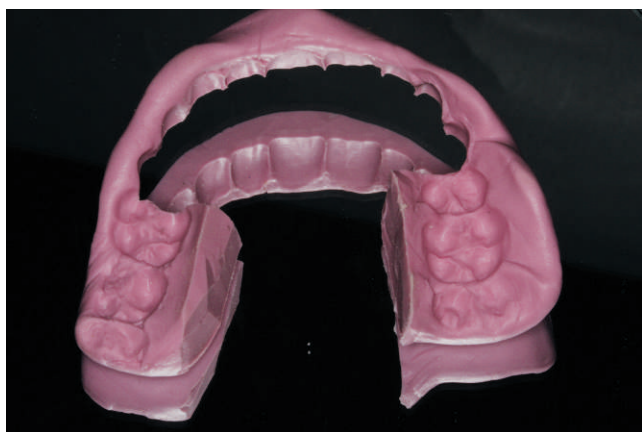


Figure 6. Putty matrix reduction guide.



Figure 7. Shade selection with Vident 3D shade guide and ovate pontic site creation after veneer preparation.

tooth interface so that abutment movement will not cause dislodgement or fracture at the pontic/wing juncture. The pontic is cut back with a veneer preparation to allow for the placement of a porcelain veneer to increase the esthetic potential.

The Encore Bridge, consisting of two components, allows for two paths of insertion. The first is for the lingual framework and the second is for the facial veneer. This is advantageous, as the proximal of the abutment teeth is not narrowed, nor is the appearance changed.⁶

The Encore Bridge can be used to replace any missing maxillary or mandibular anterior tooth if adequate clearance exists or can be created. Ideally, the abutments should not have greater than Class I mobility. There is a greater chance of debonding and fracture with increased tooth mobility. Additional contraindications would include teeth that are too thin to allow proper preparation; teeth that are too short for adequately sized connectors and resin wings; and parafunctional habits.

The teeth were anesthetized with 2 carpules of 1.7 mL of 2% lidocaine with epinephrine 1:100,000. The previous bridge (Nos. 6, 7, and 8) and composite bonding on No. 10 were removed. A Biolase Ezlase™ 940 (Irvine, CA, USA) was used to create an ovate pontic in the No. 7 site and to contour the tissue around No. 10. Keeping the teeth moist, the shade was selected (Figure 6) Aided by the use of a putty matrix reduction guide teeth (Figure 7 Nos. 5, 6, 8, 9, 10, 11, and 12 were prepared for porcelain veneers (Figure 6). GingaTrac™ (Centrix, Shelton, CT, USA) was used to obtain gingival retraction of the multiple preparations. The GingaTrac Matrix material was expressed into a stock plastic tray and placed over



Figure 8. *GingaTrac.*

the prepared teeth. The now-custom tray was removed from the mouth. The GingaTrac retraction paste was injected around and over the prepared teeth. The customized GingaTrac Matrix was then filled with the GingaTrac retraction material and placed back over the preparations and held in place for three to five minutes with firm biting pressure. The GingaTrac material was removed and complete retraction was verified (Figure 8). Access® (Centrix) impression material was used to obtain the final impression (Figure 9). Luxatemp was used to fabricate a provisional bridge and provisional veneers (Figure 10). Photographs, final maxillary impression, counter impression, bite registration, model of the provisional restorations, and putty incisal guide derived from the provisional were sent to the laboratory. Final shade selection and stump shade were specified. The laboratory was instructed to duplicate the incisal edge position as indicated from the incisal guide and to proportion the teeth as in the provisional. The degree of incisal translucency

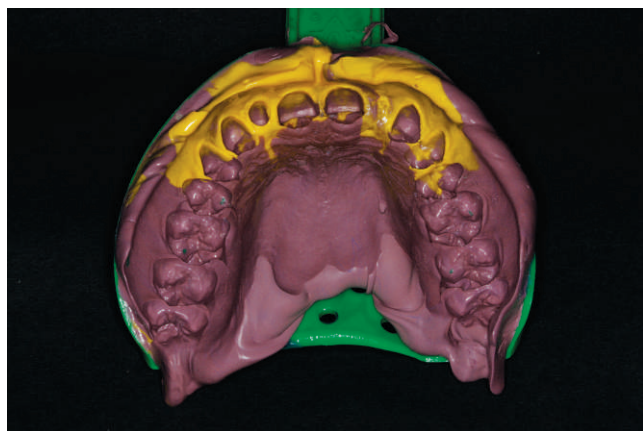


Figure 9. *Final impression.*



Figure 10. *Luxatemp provisional bridge with high smile.*

and texture were also specified. From the materials sent to them, the laboratory was able to fabricate dies and solid models and articulated the case to construct the final restorations (Figure 11).

Upon return from the laboratory, the Encore Bridge and porcelain veneers were inspected on the models. The patient was appointed, the provisional bridge removed, and the Encore Bridge and the porcelain veneers were tried intraorally. The accuracy of the margins was confirmed (Figures 12 through 14). The bridge and the veneers were cemented utilizing Prime and Bond® NT™ (Dentsply/Caulk), a light-cure self-priming dental adhesive, and Variolink II® (Ivoclar/Vivadent, Amherst, NY, USA) translucent shade. The excess cement was removed and the occlusion was verified in MIP and in excursions. A follow-up visit was scheduled for two weeks later so that the gingival response could be evaluated. The final result provided the color,



Figure 11. *Die model of prepared teeth.*



Figure 12. Framework and porcelain veneers.

shape, and contour that the patient had desired (Figures 15 through 18).

DISCUSSION

RFPDs have been used as an alternative to implants, conventional metal ceramic bridges, and all ceramic bridges. Unfortunately, despite considerable modifications in design, materials, and preparation design, the survival rates are less than 76% after five years.⁷ The literature reports that the failure is usually the result of debonding of the cast-metal framework from the luting cement. On some occasions the luting cement has debonded from the enamel. Detachment of the framework on only one abutment frequently resulted in extensive decay on that abutment. It is believed that the rigidity of the cast framework contributes to its detachment from the bonded surface. This is a consequence of the mobility of the abutment teeth under function, which results in tensile and compressive stresses at the



Figure 13. Framework and porcelain veneers on model.



Figure 14. Try-in of framework.

boundary of the metal framework and the composite luting material. In the anterior esthetic zone the metal-free RFPD has shown to be a viable alternative for single-tooth replacement. A possible explanation is the selection of a material that has a lower modulus of elasticity than do cast metals, thereby allowing for a reduction of the interface stresses. In addition, a framework that can bond more securely will reduce displacement. The mechanical properties of the fiber-reinforced composite (FRC) depend on the type, form, and quantity of the reinforcing fibers. The bonding ability will depend on the polymer matrix encasing the fibers.⁸ Glass fiber possesses a high tensile strength, but the final strength of the FRC is dependent on other factors as well. Fiber-volume fraction, stress strain of the matrix, and the fiber-matrix interface all play a role. The most common types of fibers are electrical glass and silica glass (S-glass) fibers. The S-glass fibers have greater hardness and elastic modulus and present greater resistance to plastic deformation.⁹ The fiber composites are produced with a pultrusion process that allows the fiber bundles to be pulled through an extruder at the same time as the



Figure 15. Left lateral view immediately after insertion.



Figure 16. Right lateral view immediately after insertion.

polymer. This allows the polymer to penetrate the fiber bundle and creates the final cross-sectional shape. The framework used in this case, Sculpture/FibreKor, consists of the veneering composite Sculpture Plus Nano-Hybrid, a polycarbonate composite, and FibreKor material. FibreKor material is a unidirectional S-2 glass material. Unidirectional materials are termed anisotropic. They reinforce FRC materials to the utmost when stress is applied along the direction of the fibers.⁹ The strength of these materials diminishes when a stress is applied in an oblique or perpendicular direction. The efficiency of any given level of fiber loading is called the Krechel factor. The Krechel factor is 1 for FiberKor. A material with a Krechel factor of 1 has the fibers oriented in one direction and gives the greatest amount of reinforcement for a given fiber loading. Woven fibers that reinforce FRC materials in two directions are described as orthotropic, with half the fibers in a longitudinal direction. The result is a reinforcing efficiency (Krechal factor) of 0.5.⁹ The maximum bite force of normal incisors is 150–200 N.¹⁰ The unidirectional fiber “FibreKor” can reinforce the framework when the forces are not



Figure 17. Final labial smile.

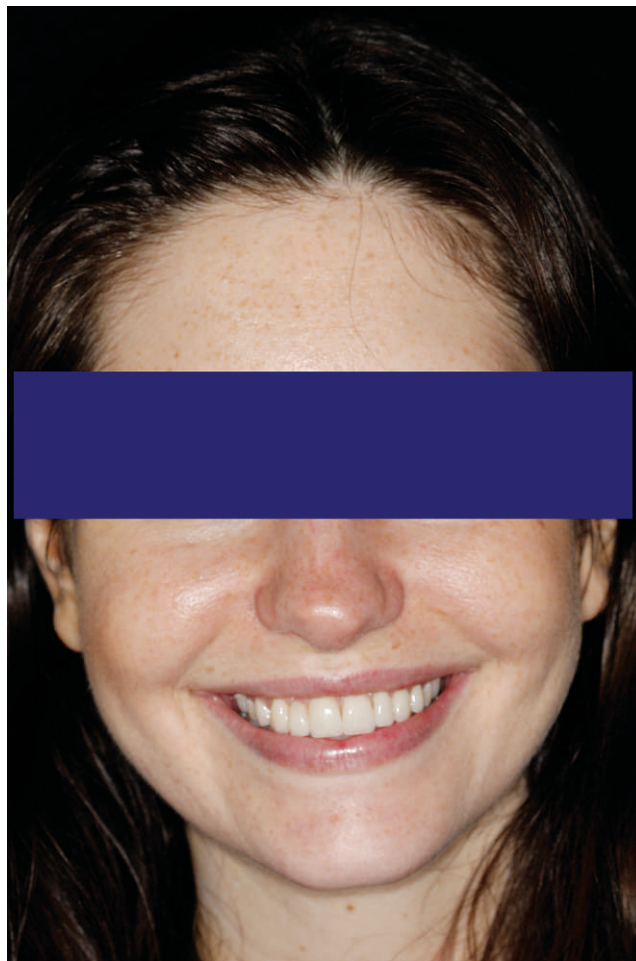


Figure 18. Full facial smile.

directed along the axis by placing the unidirectional fibers in multiple directions. When the direction of the force is not parallel to that of the fibers, the mechanical properties decrease and are more contingent on the resin matrix. In the pontic area a high percentage of unidirectional glass fibers are placed in a mesiodistal direction to maximize strength.¹¹

The RBFPD allows an esthetic treatment option with minimal tooth modification.^{12–14} The Encore Bridge requires a groove with a depth of 0.5 mm, a width of 1.0 mm, and a clearance of 1.0–1.5 mm incisally and cervically. While traditional metal ceramic complete-coverage fixed partial dentures will have the maximum strength and all-ceramic fixed partial denture will provide excellent esthetics, a more destructive tooth preparation will be required. The advent of better adhesives has led to the development of simplified, minimally invasive preparations. While the best bond strength is still to enamel, bond strengths to dentin are reasonably good.¹⁵

In vitro studies¹⁶ demonstrated that FRC material displays flexural strength that is greater than or similar to that of metal alloys, but it has a lower flexural modulus. Composite resin is a brittle material and would be unable to support protracted occlusal forces in the pontic area of a bridge. Incorporation of fiber into the composite matrix results in increased strength and toughness.¹⁷ The load-bearing capacity can be further increased by placing an additional piece of unidirectional FRC on the occlusal surface. However, the FRC must be placed in a buccolingual direction.¹⁸ Patients with firm anterior occlusal contacts will require more preparation in order to obtain the additional 0.5 mm needed to assure adequate thickness of the wings.²

CONCLUSION

Esthetic assessment prior to initiating treatment is critical to achieving the best outcome. Proper guidance in protrusive and lateral excursions must be established to ensure longevity of the restorations. Selection of the best materials to achieve these parameters is of the utmost importance. A systematic approach leads to a more predictable result. The FRC fixed dental prostheses can present a viable substitute for a cast-metal resin-bonded bridge. It is minimally invasive and can often be repaired with direct composite resin if required.¹⁹

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Conflict of Interest

The authors of this article certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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