Esthetic Rehabilitation of Anterior Teeth -Fiber-reinforced Composite: A Case Report

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Abstract

Patients refusing implant surgery for psychological reasons, where minimal tooth reduction is preferred, a fiber-reinforced composite inlay fixed partial denture (IFPD) can be a good alternative to conventional prosthetic techniques. In comparison to other restorative systems this is a conservative approach carries a minimum jeopardy of pulp exposure or sensitivity and periodontal inflammation, maintaining the health of supporting tissues. The purpose of this case report is to illustrate the clinical procedure for fabricating an IFPD with a pre-impregnated glass fiber system and a hybrid composite. Fiber-reinforced composite, in combination with adhesive techniques, appears promising for an IFPD. Further clinical investigation will be required to provide additional information on this technique.

Keywords: *Adhesive dentistry, fiber-reinforced composite, glass fibers, metal-free restorations, Vectris system*

I. Introduction

Different therapeutic options can be considered for the replacement of a congenitally or traumatically missing permanent incisor in young children and adolescents.

Implants are the treatment of choice and should be considered when general and local conditions are favorable. Their use is generally not intended before the end of the growth period and around the age of 18. Because of their high cost, poor financial condition could also limit their use. More economically acceptable treatments should, therefore, be investigated for the replacement of a missing tooth, as a main treatment or as a long-term provisional treatment before implant therapy.

Partial removable dentures are often recommended for very young patients when adjacent teeth are not in their final vertical and horizontal positions. These dentures could be modified when necessary by adding or grinding the acrylic resin. They are not comfortable, however, and are frequently subjected to fracture. When an orthodontic treatment is indicated, an artificial plastic tooth can be attached to a removable or fixed orthodontic appliance to solve the esthetic concern.

The replacement of a missing tooth can also be made via a conventional porcelain-fused-metal (PFM) bridge or a resin-bonded fixed partial denture (Maryland bridge). The former is the most invasive treatment in terms of tooth reduction and could be aesthetically compromised with gingival contour modifications. The latter is less invasive, but the non-esthetic aspect of the metal framework, necessity of dental reduction or preparation (grooves, etc.), challenging long-lasting bonding of metal to tooth, and lack of longevity could limit its use.

The fiber-reinforced composite (FRC) bridges represent an interesting alternative to conventional metal bridges.1 They could be made directly or indirectly using an artificial plastic tooth or the avulsed tooth,[2,3] or by a direct build up composite resin tooth with[4,5]or without[6] porcelain veneering.

Whenever possible, a FRC bridge should be fabricated extraorally to achieve better polish, polymerization conversion rate, and adaptation. The material used for the cast fabrication can be conventional gypsum materials. Two appointments are, therefore, necessary for this indirect technique. Moreover, the separation of the final work from the cast could be delicate if undercuts are filled by composite resin.

The new generation of composite resins with dentin and enamel shades provides very good aesthetic results by reproducing the natural aspect of the tooth, mainly in the incisal third of anterior teeth.[7]

The use of unreinforced composite resins as the structural material for bridges often results in fracture. Composites are brittle materials and contain bubbles, cracks, and other defects causing or facilitating fissure propagation and fracture.[8] It has been demonstrated that the reinforcement of a composite resin by fibers increases the fracture toughness and resistance.[9] The combination of an esthetic, wear-resistant composite resin, and tough fiber material gives a new option for short-span composite bridge fabrication.[10]

Structurally, the fiber-reinforced composite is made up of two components: the fibers and the
resin matrix. The resin matrix serves as carrie protector, and load-splicing medium around the fibers. To improve the mechanical properties of composite resins and to optimize the mechanical behavior of the material, specifically-oriented filler materials, such as glass fibers, aramid fibers, carbon/graphite fibers, and ultra high molecular weight polyethylene fibers (UHMWPE), have been proposed. Polyethylene and glass fibers are the materials most frequently used for FPDs. *In vitro* studies have shown the clinical and mechanical performance of FRC depends on several factors, including fiber direction and pretreatment.
Unidirectional fibers are anisotropic with high strength in one direction, while bidirectional fibers give so-called orthotropic properties to the material in one plane and random-oriented fibers give isotropic properties[11] In order to reinforce the restoration in multiple directions woven fibers and meshes have been proposed.[12] Resin-preimpregnated and non-impregnated fibers are available on the market. Pretreatment of fibers with a silane coupling agent appears to minimize shrinkage on polymerization and reduce cracks and pockets, ensuring reliable adhesion between fibers and resin matrix.[13]
This article describes a clinical case in which an (FRC) bridge is fabricated according to the semidirect technique for the replacement of a traumatically missing central permanent incisor.

II. Case Report

A 23-year-old boy visited in the Department of Prosthodontics, with the chief complain of missing anterior teeth since 8months. The patient revealed no specific medical history, with the dental history of periodontitis which was responsible for the extraction of the right maxillary permanent lateral incisor.

Preoperative frontal view with a missing right maxillary lateral incisor

The esthetic aspect of this tooth was rated unsatisfactory by the patient, who asked for a more esthetic and comfortable treatment. For the intra oral examination it was found missing 22, 46, 35, 36 teeth. All therapeutic options, from implant to conventional Maryland bridge, were, therefore, possible in this case.
After discussing all treatment options with the patient, It had been decided to place a fiber-reinforced composite Maryland-like bridge until the implant treatment. No tooth reduction was necessary because the anterior overbite was minor.
An impression was made with alginate for the FRC bridge fabrication. The impression was poured with type IV gypsum material. The length measurement was conducted with thin soft foil. This foil was directly adapted to the working cast. The foil extended to the middle thirds of each abutment and passed over the pontic area directly under the incisal edge. The foil was used as a guide, for the exact length of the ribbon needed for fabrication of the FRC bridge. One should avoid touching the ribbon until after it is wetted with bonding resin via the fingers, because any contact can contaminate its reactive surface layer.

Final lingual view of the bridge after bonding, finishing, and polishing

The reinforcement material was impregnated with a hydrophobic solvent-free bonding resin (One Coat Bond SL, coltene). Following the impregnation with the bonding resin, the fiber material became translucent. The excess unfilled bonding resin was blotted with a gauze. The ribbon was kept out of the dental light until used. A thin layer of a microhybrid restorative material was placed on the lingual side of the abutment teeth. This composite acted as adhesive and held the ribbon during its adaptation. Using instruments, the ribbon was pushed through the uncured composite layer until it touched the surface of the die material. Like the foil, the ribbon crossed the pontic area under the incisal edge, going from the labial lingual midline of each abutment.

The thickness of the composite between the teeth and ribbon was kept as thin as possible. The ribbon wings and beam were light cured for 40 seconds to form a strong framework for the FRC bridge fabrication. A second fragment of the ribbon was placed in the pontic region at this stage. A silicone spatula was used to model the composite and obtain a very thin layer of the covering composite. This technique provided a bubble-free and harder surface in comparison to the use of a flowable composite as the smoothing layer.

The composite pontic was built around the composite laminate framework. To obtain a good natural esthetic result, a composite restorative system (SwissTEC, Coltene) containing different enamel and dentin shades was used.

Dentin shades, responsible for the opacity, hue, and chroma, were placed internally and then covered by enamel shades. The bridge was finished and polished with appropriate instruments.

The bridge was inserted into the mouth to check its fit. It was rinsed with alcohol to remove any traces of polishing pastes, then rinsed with water and air dried. The internal side of the wings was acid-etched (Scotchbond™ Universal Etchant , 3M ESPE) for 1 minute and then thoroughly rinsed and completely air dried. A porcelain primer (Silane, 3M ESPE) was then applied for 30 seconds and air dried.

Final view of the finished bridge

Enamel surfaces were etched with 32% phosphoric acid (Scotchbond™ Universal Etchant , 3M ESPE) for 30 seconds. After rinsing, all surfaces were air dried, visually inspected or proper acid etching and covered by 2 layers of a universal 1-bottle adhesive (One Coat Bond SL, coltene). The adhesive layer was air dried and light cured for 10 seconds. A thin layer of dual-cured luting composite (RelyX U200, 3M ESPE) was placed on the wings' internal surface. The bridge was inserted slowly and continuously. Once in place, it was held firmly in position. Excess cement was removed using a probe and brush. The bridge was then light cured for 2 minutes in different directions. Occlusion was verified before intraoral finishing and polishing. The final result was a well-adapted bridge with a natural esthetic result.

III. Discussion

The replacement of a congenitally or traumatically missing tooth could be performed via different therapeutic options. FRC bridges are one of these options, with several advantages including bond ability, reparability, ease of fabrication, and relative longevity and cost effective & labor intensive. This is a minimally invasive procedure with very little or no tooth preparation.

Compared to direct technique, the indirect technique described in this article provides a better result in terms of adaptation, rate of polymerization, reduced chair side time and final finishing and polishing of the bridge. With a direct technique, it is very difficult to control and avoid the excess composite in embrasures and undercuts. After curing, the composite can only be removed by rotary instruments. The use of burs is time consuming, imprecise, and possibly invasive. The lack of visibility and access could lead to fiber exposition during finishing and polishing procedures and achieving these procedures with clean dry field become difficult.

The fabrication of an FRC bridge by using a die model brings advantages in comparison with traditional indirect technique. A chair side FRC bridge fabrication could be performed easily, reducing lab fees and time. The model allows for the easy removal of the final work without weakening or breakage of the bridge. Moreover, the FRC bridge fabrication can immediately be undertaken with no required isolation.

Plasma-treated polyethylene fibers reinforce the final structure by being a physical part of the composite. FRC bridge compared to metal Maryland bridge is easier to bond, more esthetic with no metal silhouette, and does not show through the very translucent dental hard tissues in young permanent teeth.

The use of different dentin and enamel composites to build up the intermediate tooth according to the anatomical layering technique provides a vital final aspect, with natural opalescence, translucency, and opacity. The use of a denture tooth could also be considered instead of direct fabrication of the missing tooth. This method is easier, faster, and more esthetically acceptable.

The mechanical properties of FRC must be improved so as to reduce the risk of clinical failure due to catastrophic fracture.14 The fracture strength of FRCIFPD depends on several factors including: the elastic modulus of the supporting substructure, the preparation design, occlusal load of the span and the characteristics of the manufacturing process, and the materials used to fabricate the prosthesis.

Few studies have emphasized on cavity preparation for FRC, and the principles governing standard cavity preparation have not been established. When making box preparations for an FRC, if pre-existing restorations are present, they can determine abutment shape. Otherwise, when teeth are intact, mechanical and biological aspects must be considered in choosing the preparation design: the proximal box should be as deep as possible in the gingival direction to ensure an adequate amount of FRC and to provide maximal strength in the connection area. At the same time, the margins must be located within the enamel for better long-term marginal adaptation.[15] The manufacturing process also influence the mechanical properties of the FPD.

IV. Conclusion

Replacement of missing tooth with FRC technique offered in this article suggests a new treatment alternative. This technique restores esthetic and function. It is more comfortable than a removable appliance, nonirritating, and hygienic. It does not require any tooth reduction or minimum reduction is required and could be repaired, modified, or removed from teeth without any iatrogenic problem. It can be considered a stable treatment or a long-lasting provisional treatment if implant therapy is used at a later date. In this case, the noninvasive characteristic of this treatment render it superior to all other options.

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