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Rehabilitation of an extracted anterior tooth space using fiber-reinforced composite and the natural tooth

CASE REPORT

Bora Bagis, Ipek Satiroglu, Fatih Mehmet Korkmaz, Sabit Melih Ates

Department of Prosthodontics, Faculty of Dentistry, Karadeniz Technical University, Trabzon, Turkey

Correspondence to: Fatih Mehmet Korkmaz, Department of Prosthodontics, Faculty of Dentistry, Karadeniz Technical University, Kanuni Kampüsü 61080, Trabzon, Turkey
Tel.: +90 533 2582140
Fax: +90 462 325 3017
e-mail: fmkorkmaz@hotmail.com

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Abstract – Conservative solutions for the restoration of a single edentulous space in the anterior maxilla present an esthetic challenge to the clinician. A 45-year-old male patient whose right upper central tooth was planned to be extracted was referred to our clinic for a conservative, rapid, and economic treatment. After radiographic and clinical examinations, it was decided that the tooth which was to be extracted should be used for the restoration of its own extracted area. The extracted tooth was splinted to adjacent teeth with the aid of the grooves and fiber-reinforced composite (everStick®, StickTech Ltd., Turku, Finland). Following an early and unexpected failure of the restoration, the fiber layer was thickened twice with a flowable composite resin (Stick Flow, Stick Tech Ltd.) which fit better to the grooves. The restoration satisfied the patient with a good mechanical behavior, esthetics, and long-term durability after 12 months while. Restoring the missing tooth area with the patient's own tooth is advantageous when combined with modern adhesive techniques. The clinician must pay attention to the mechanical adaptation of the restoration and the technique sensitivity of the applied adhesive system.

Most dentists will eventually encounter esthetic difficulties when constructing anterior prostheses (1). When a single tooth is extracted from the anterior region, the patient expects immediate and esthetically pleasing restoration of the edentulous space (2). The most preferred prosthodontic treatment options for a single missing tooth are the conventional fixed bridge, a resin-bonded bridge, and a single-tooth implant (3). All of these approaches require multiple visits to achieve a perfect result, but replacing a missing tooth in a single visit is possible by using adhesive techniques with resin composites and glass fibers (4).

Fiber-reinforced composite (FRC) resin technology offers a variety of solutions to many complex problems in dentistry. Strength and stiffness are the two important mechanical properties for FRC resins. In addition to these properties of FRC resins, desirable esthetic characteristics, ease of use, adaptability to different shapes, and the possibility of direct bonding to tooth structures increase the popularity of these materials (2). Other advantages include reduced cost compared with conventional bridges, absence of metal allergies, and a natural feeling. Limitations, however, include traumatic occlusal relations and the presence of unsuitable abutment teeth that prevent suitable adhesive bonding (5).

Tooth replacement with fiber-reinforced technology involves the use of extracted teeth (6), acrylic resin-denture teeth, with or without lingual wire reinforcement, and resin composites (7, 8). These materials have limitations, including over-bulking, insufficient bonding, poor esthetic outcome, and poor handling characteristics (2).

This article describes a chairside procedure for rehabilitating an extracted tooth space using the natural tooth and a FRC resin.

Case report

A 45-year-old male patient was referred to our clinic for a fractured right upper central tooth. After oral and radiographic examinations, the decision was made to extract the central tooth (Fig. 1). Because of time constraints and patient expectations, the patient wanted to use the tooth in the restoration of its own extracted area. The patient was informed about possible discoloration and failure of the tooth. After extraction, the tooth was freed of debris and kept in sterile saline solution while bleeding was being controlled. Following pulp removal, the pulp chamber was sealed with a micro-filled hybrid composite (Gradia Direct Anterior, GC Corp., Tokyo, Japan, shade A3) and formed into a convex pontic shape using composite resin. Because of the need for mechanical support, a groove was made in the mid-palatal section of the extracted tooth (Fig. 2). The mesial and distal contours of the extracted tooth were enlarged with composite resin and adapted to the edentulous

Fig. 1. Clinical view of the patient and the extracted tooth.

Fig. 2. The prepared tooth, etching and bonding process.

Fig. 3. Palatal and final view of the first restoration.

space. The extracted tooth was fitted into the edentulous space with the aid of bonding resin, without acid etching, to control rotations during the treatment. The adjacent central and lateral teeth were also prepared as grooved using a round diamond rotary instrument (Microdont, São Paulo, Brazil) at nearly 1-mm depth (9). The tooth was cleaned using pumice and water, rinsed, and air-dried. The grooves were horizontal canals to accommodate the width and thickness of the FRC resin reinforcement material in the middle one-third of the tooth.

The required length of fiber (everStick®; StickTech Ltd., Turku, Finland) was measured using dental floss between the adjacent teeth. Ideally, the fiber should cover two-thirds of the width of the supporting teeth's palatal surfaces (10). The required amount of fiber was cut, together with its silicone bedding. Protecting the fiber from light by placing it under a cover before application is important.

The palatal and proximal surfaces of the adjacent teeth and the extracted tooth were etched with 37% phosphoric acid (Scotchbond Etchant™; 3M ESPE, St. Paul, MN, USA). The teeth surfaces were rinsed with water and air-dried after etching. The bonding agent (Adper™ Single Bond 2; 3M ESPE) was applied and light-cured according to the manufacturer's instructions using a light-emitting device (Mini LED; Satelec Acteon Group, Merignac, France; Fig. 2). A thin layer of flowable composite resin (Stick® Flow; StickTech Ltd.) was applied to the palatal groves and the proximal surfaces of the adjacent teeth.

The fiber was pressed into the resin with the aid of a Stick® Stepper (StickTech Ltd.) hand instrument to ensure that it fit into the grooves and then light-cured from multiple directions for 20 s. Covering the fiber entirely with composite resin is important, including the interproximal areas forming embrasure spaces, to enable the patient to clean the bridge and proximal areas.

The occlusion was evaluated with articulating paper, and premature contacts were eliminated. The restoration was polished (Sof-Lex™; 3M ESPE). The extracted tooth was replaced in its space with the aid of glass fiber, composite resin, and grooves. The apical part of the tooth was shaped after the bleeding was controlled (Fig. 3).

The patient returned with a separated pontic at the end of the first month postprocedure (Fig. 4). Although the tooth that was used as a pontic was kept in water for a couple of hours, discoloration of the dehydrated tooth was noticed. The tooth was again kept in saline solution until a treatment decision was reached. After a brief examination, the conclusion was made that adhesion of

Fig. 4. The detached tooth and the fiber frame.

the fiber frame with the abutment teeth and the fiber frame itself were not the problem, although a debonding problem occurred between the extracted tooth and the fiber frame. While trying to replace the tooth for a second attempt at rebonding restoration, insufficient adaptation of the fiber and the groove was noted. To strengthen the restoration, the decision was made to thicken and adapt the fiber frame to the groove of the separated tooth. During this adaptation process, the groove was prepared again and the fiber frame was thickened with the aid of flow resin and fiber pieces. Before rebonding, the apical end of the pontic tooth was shaped with composite resin to compensate for bone resorption. The etching and bonding processes were repeated for the newly formed pontic tooth and fiber frame. The final steps included adjustment of occlusion and esthetic contouring of the restoration and polishing the restoration. The patient was informed about the importance of proper hygiene and was followed up periodically. He was satisfied with the results after 12 months and did not complain of any color problem (Fig. 5).

Discussion

This clinical report describes the replacement of a single-tooth vacancy using the patient's own natural tooth as a pontic and FRC, along with the failure of the restoration and its subsequent repair using the detached pontic. Single-tooth replacement options include conventional fixed bridges, a single-tooth implant, and a resin-bonded denture. Conventional metal–ceramic partial fixed dentures provide maximum strength, but all-ceramic partial fixed dentures are metal-free and esthetically more pleasing. Furthermore, a resin-bonded fixed partial denture allows for more conservative tooth preparation (11). Dental implants in the esthetic zone are well documented in the literature, and numerous controlled

Fig. 5. View of the final restoration after 12 months.

clinical trials have documented satisfactory overall implant survival and success rates (12). Such restorations are sometimes complicated by the cost of the restoration, patients' fear of the surgical procedure, and anatomical limitations. The development of adhesive systems has provided other treatment options with minimally invasive preparations and is often simpler (13, 14). Replacement of a single tooth using the FRC technique was preferred in the current case due to the better adhesion of the composite luting agent and fiber to the dental structure, physiological stiffness of the fiber frame, and of course good esthetics (15). According to a clinical 5-year follow-up pilot study, glass-FRC fixed partial dentures exhibited an overall survival rate of 75% and functional survival rate of 93% (16). Previous attempts at chairside tooth replacement involved using various types of pontics, such as the extracted tooth (6), acrylic denture teeth (with or without lingual wire reinforcement), porcelain denture teeth (7), and resin composites (7, 8). The use of the extracted tooth, aided by the impressive bond strength of dental adhesive materials, provides an option to treat patients with less invasive tooth preparation, favorable esthetics, and a natural feeling. Although some studies have suggested that laboratory-made composite materials appear to function well, with the development of veneering materials and polymerizing techniques, compared to traditional materials (15, 17, 18), the wear resistance of laboratory veneering composites is highly variable (19). Moreover, replacing an extracted tooth with an acrylic resin tooth is associated with a greater degree of color change as compared to porcelain (20).

The reinforcement of composite resins with fibers improves their fracture resistance. The composites' properties can be manipulated by changing fiber orientation, fiber content, and geometry (21). One of the influencing factors of FRCs' mechanical properties is impregnation of fibers with resin (21, 22). Several types of fiber can be used to reinforce the composite resin. The use of resin preimpregnated, silanized glass fibers in place of non-impregnated polyethylene fibers improves mechanical properties (23). Glass-fiber fixed partial dentures have esthetic and economic advantages and are easy to repair, so they are preferred by both dentists and patients (7, 24).

Bonding of the restoration to adjacent teeth is important for the success of single-tooth restorations. In addition to preparing grooves on all the related teeth, bonding of the restoration is essential. The predominant location of debonding with resin-bonded fixed partial dentures is between the luting cement and the framework of the denture (25). In the present case, unexpected and early failure occurred between the pontic tooth and the fiber frame. One likely explanation for this failure was the inadequate adaptation of the fiber frame to the groove of the extracted tooth. Such insufficient adaptation might be the reason behind the technical difficulties inherent in constructing these kinds of restorations and the polymerization shrinkage of the FRC. When the restoration requires additional resin cement to lute, the mechanical strength of the resin cement might be insufficient to overcome chewing forces. Thus, the adaptation could only be managed by adding more fiber to the present fiber frame. The fracture resistance of a three-unit provisional fixed partial denture was found to be increased by adding glass-fiber reinforcement (26). Additional fiber was bonded to the fiber frame to enhance the restoration. When the fiber was thickened and the adaptation was increased, luting the detached pontic tooth to the frame required less resin cement.

In conclusion, this report describes a rapid and conservative chairside technique for restoring a missing single anterior tooth using the natural tooth and a FRC. After the unexpected failure of the restoration in a short time, poor adaptation of the fiber frame and the groove was determined to be the reason for the failure. As well as the bonding system, mechanical adaptation and the retention of the fiber frame and the grooves of the pontic are fundamental for the success of this type of adhesive restoration.

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