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Clinical Applications of Glass Fiber Reinforced Composites: A Case Series

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Abstract

Dental resin composites have seen a substantial improvement in terms of toughness, rigidity and flexural strength with the development of Fiber Reinforced Composite (FRC) Systems. Esthetic dentistry has seen a major leap in advancements with the beginning of the era of the FRC technology. The biocompatibility, translucency, ability to bond to tooth structure and the possibility of direct chair side application has made life easier for the dentist, providing improved results with ease and reliability. This paper attempts to showcase the versatility and applicability of this wonderful material (FRC) in day-to-day dental practice.

Keywords: *FRC, Fixed partial denture, Post and core, core buildup, Splinting*

Introduction

Fiber reinforced composite (FRC) technology has brought about great changes in the properties of dental resin based composites, including increased flexural strength, rigidity and toughness. [1]

Various types of fibers and other materials including carbon, graphite, glass, Kevlar have been considered, and their technique of usage investigated, to provide this form of reinforcement. [2, 3]

The fibers may be arranged in a unidirectional manner, with every fiber running in a single direction, or, alternatively, may be present in a weave or meshwork pattern.

Various factors such as loading of fibers in the restoration, bond efficacy at the fiber-resin interface, orientation of the fibers and their position in the restoration may cause changes in the physical, mechanical, thermal and optical properties of the material.[4]

Super-Splint is a reinforcement glass-fiber system composed of fibers that are arranged in a multidirectional leno-weave. This material has been developed as a reinforcement system, with the proposed advantage of being tear proof. [5] Super-splint is bondable with all composite resin systems. As purported by the manufacturer, its biocompatibility is high.

Glass fiber ribbon can be used in the splinting of periodontally weak teeth, as endodontic post and cores, in the splinting of traumatized teeth, and as space maintainers. [6] Reinforcement fibers have proven to prevent fractures that occur due to high masticatory stresses by increasing the fracture toughness and flexural strength of composite resins. [7, 8]

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With the advantages of translucency, biocompatibility, bondability to tooth structure and direct chair side usability, this technology has greatly benefited the dentist with its ease of use and reliable performance. This paper shows the versatility and applicability of FRC in day-to-day dental practice.

Case reports

Case 1- FRC fixed partial denture

A 32-year-old female patient reported to the department with discoloration and mobility in her upper front tooth. Clinical examination revealed deep caries involving pulp and grade III mobility of the primary maxillary right lateral incisor.(Figure 1A ,1B) After clinical and radiographic examination, extraction of the primary tooth followed by a fixed partial denture with Super-Splint (Hager Werken, Duisburg, Germany) using composite as a pontic was suggested.

After etching and bonding was performed, the lingual and proximal surfaces of the abutments were coated with a thin film of a flowable composite material (Filtek™ Z350 XT flowable restorative, 3M, USA), leaving the resin uncured.

A 10 mm strip of Super-Splint Glass fiber resin was placed on the lingual surfaces of the maxillary right central and lateral incisors, followed by the application of pressure using a hand instrument to obtain a close contact interproximally. (Figure 1C)

After removal of excess material, a light emitting diode (LED) Light curing unit (Bluephase, Ivoclar, Vivadent) was used to light cure the splint and resin for 20 seconds.

Following this, free hand light cured composite resin (Filtek™ Z350XT Universal Restorative, 3M, USA) build up was done to mimic a lateral incisor (pontic) which was then adapted to the splint using a flowable composite and cured for 20 seconds. After finishing and polishing of the restoration, an appealing result was obtained, which satisfied both the clinician and the patient. (Figure 1D)

Figure 1 A&B: Intraoral view showing retained deciduous maxillary right lateral incisor (labial and palatal view); C: FRC placed on the palatal surfaces of the maxillary right central and lateral incisors; D: FRC Fixed Partial Denture

Case 2- Endodontic post and core

A 40-year-old female patient reported to the department with a chief complaint of fractured upper front tooth. The patient gave a history of a root canal treatment performed on the tooth one year prior. There was no history of bleeding at the area of interest and the medical history was non-contributory. Intraoral examination showed a fractured maxillary right lateral incisor with less than half of remaining tooth structure. (Figure 2A) Radiographic examination revealed satisfactory obturation.(Figure 2B)

Since there was considerable tooth structure loss, the tooth was planned to be restored with Super-Splint in the form of an endodontic post.

A post space was prepared on the maxillary right lateral incisor (Figure 2C) after which etching (Eco Etch, Ivoclar, Vivadent, USA) was performed for 15 seconds. The etchant was removed with thorough water rinsing for 30 seconds and the tooth was air-dried. Paper points were then used for the drying of the canals. A micro-brush was used to apply two coats of an adhesive (Adper Single Bond 2, 3M ESPE, USA) following which the solvent was evaporated by gentle air-drying. Adhesive was then used to wet the Super-Splint and it was placed in the post space along with resin cement (Variolink, Ivoclar, Vivadent, USA) and cured with a light emitting diode (Bluephase, Ivoclar, Vivadent, USA) light curing unit(Figure 2D). Building up of the crown was done with a light cured composite material (Filtek™ Z350XT Universal Restorative, 3M, USA) to complete the procedure(Figure 2E & 2F).

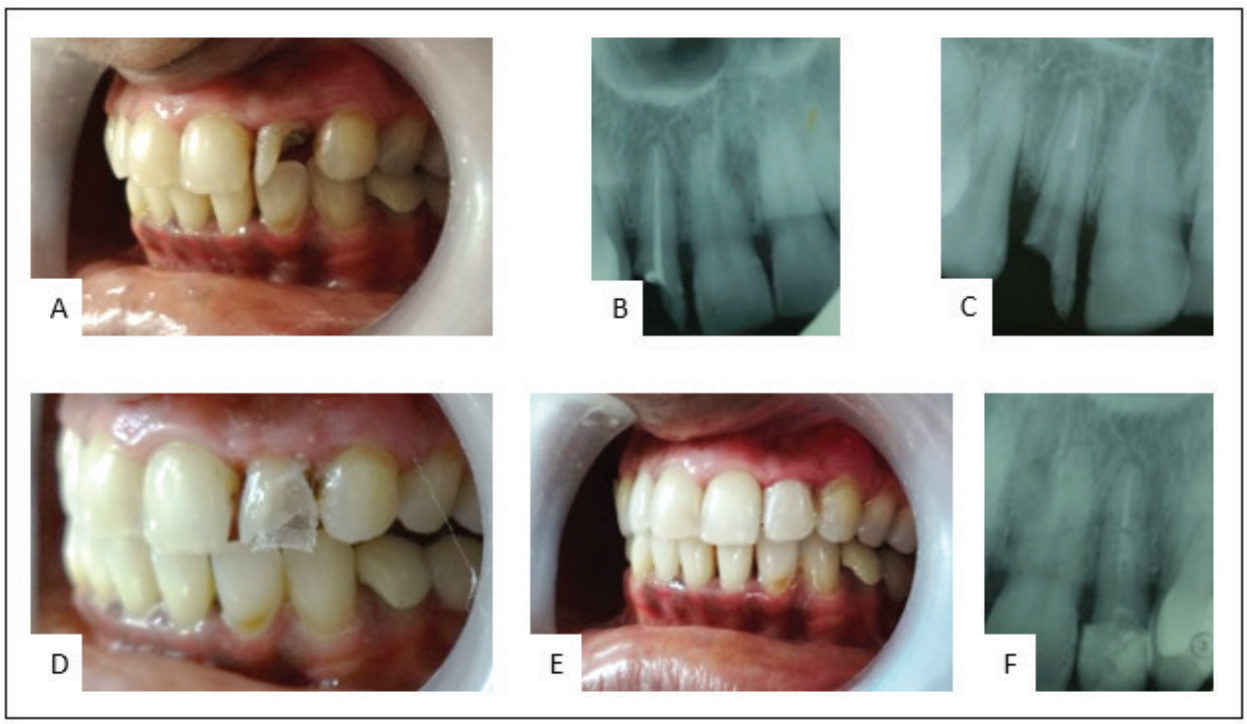

Figure 2:A-Intra oral view showing fractured right lateral right lateral incisor; B-IOPA showing satisfactory obturation in incisor; C-IOPA showing post space preparation D- IOPA showing FRC as moldable post; E & F-Clinical and radiographic view showing composite build-up

Case 3- Splinting of traumatized teeth

A 35-year-old female patient was referred to the department two hours following a traumatic injury that resulted from a road traffic accident. On examination an Ellis class III fracture of the left maxillary lateral incisor and moderate mobility of the permanent maxillary anterior teeth was observed. (Figure 3A) The decision was made to splint the maxillary anterior teeth for patient comfort using Super-Splint. After etching, rinsing and drying of the labial surfaces of the anterior teeth from the maxillary left canine to the right, a fifth generation

bonding agent (Adper Single Bond 2, 3M ESPE, USA) was coated on to the teeth and light curing was performed for 20 seconds using a light emitting diode light curing unit (Bluephase, Ivoclar, Vivadent, USA). A flowable composite was applied to the teeth, and Super-Splint was pressed into the composite and cured. An additional layer of flowable composite was then placed over the cured material and cured for another 20 seconds (Figure 3B). After two weeks, a diamond point was used to cut the Super-Splint at the interproximal areas. The splint was then removed using a scalpel blade, by inserting it in between the tooth and the splint on the distal-most end. A tungsten carbide bur in a low speed handpiece was used under a water coolant to remove the remaining material, and the tooth surfaces were then polished using disks

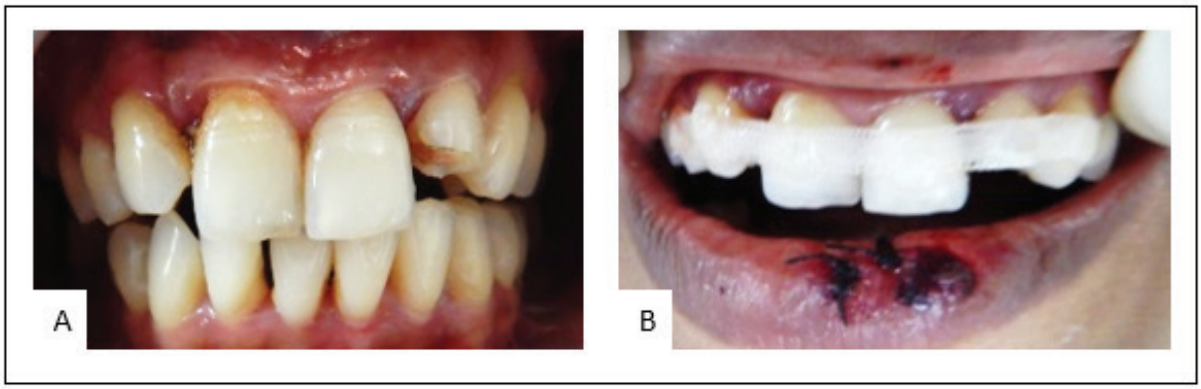

Figure 3 A- Pre-operative view; B-Post-operative view

Case 4: As a reinforcement of composite restoration

A 30 year old female patient reported to the department with a chief complaint of a broken filling in her left lower back teeth region. The patient gave a history of a root canal treatment performed on that tooth 1 year back. On clinical examination the mandibular left first molar showed a fractured post endodontic restoration. Radiographic examination revealed satisfactory obturation. The decision was made to restore the endodontically treated tooth by composite restoration reinforced by glass fiber ribbon.

The old restoration was removed, and the tooth was cleaned, dried, and etched with 35% phosphoric acid (Eco Etch, Ivoclar, Vivadent, USA) for 15 seconds. The teeth were then rinsed for 10 seconds and air-dried for 1-2 seconds. Subsequently, a single bottle total-etch adhesive system (Adper Single Bond 2; 3M ESPE, St. Paul, MN, USA) was applied and photocured using a light-emitting diode light curing unit (Bluephase, Ivoclar, Vivadent, USA) for 10 seconds. A glass-fiber ribbon saturated with bonding agent was placed in a bucco-lingual direction and cured for 20 seconds. A layer of nanocomposite was placed over the exposed fiber surface. Then another strip of fiber saturated with adhesive was placed in a mesio-distal direction and cured for 20 seconds. Finally, the occlusal surface of the tooth surface was built with light-cured composite.

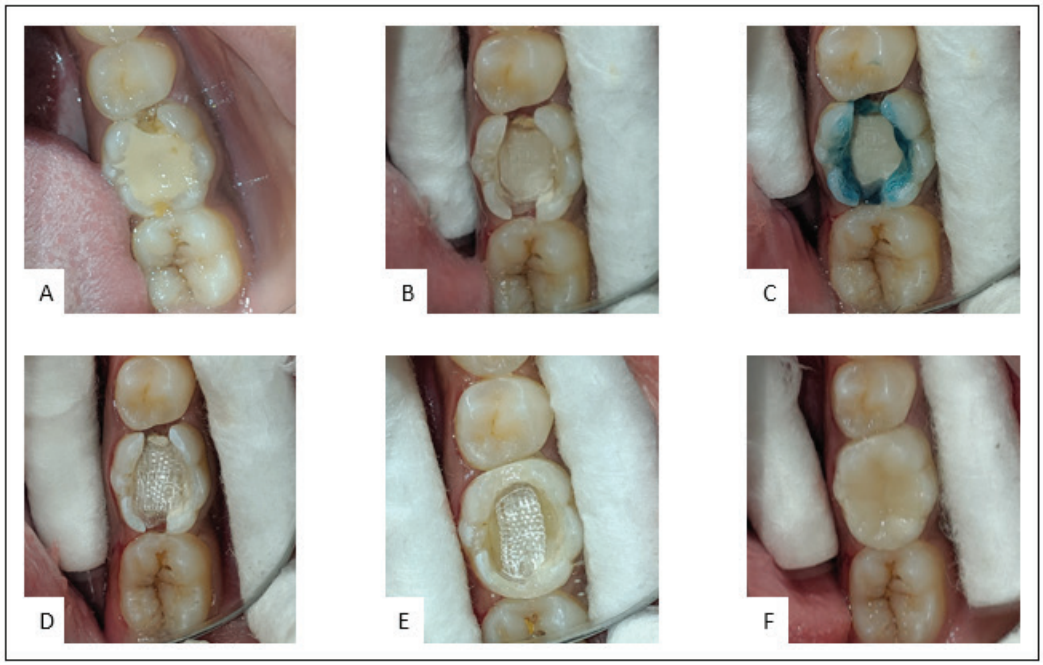

Figure 4: A- 36, Fractured post endodontic restoration; B- Removal of fractured post endodontic restoration and application of base; C- Etching with 37% phosphoric acid; D- Two fiber strips inserted inside the cavity and adapted over the pulpal floor in bucco-lingual direction using adhesive resin; E- Fiber strip placed mesio-distally before the final composite build up; F- Composite build up

Discussion

Fiber reinforcement has increased in popularity over the recent years, due to its versatile applications, which include Fiber reinforced composite bridges, periodontal splints, posts, as orthodontic retainers, and as FRC resins. These materials provide several mechanical advantages such as superior flexural strength, fatigue strength, bond strength and modulus of elasticity.

FRC fixed partial dentures have been suggested as esthetic and functional alternatives to conventional prostheses for the replacement of missing teeth. [9] They are hygienic, non-irritating, and have been proven to provide more comfort to the wearer than the conventional removable appliances. They have the additional advantage of requiring no tooth preparation, and have the capacity to be modified, repaired, or removed, while causing minimal iatrogenic damage. The possible pontics for such FPDs include the patient's natural dentition, or teeth made of acrylic or composite resins. With proper etching and bonding procedures, FRC FPD's have proven to be reliable and clinically stable.[10]

Endodontic post-and-core systems are designed to provide reinforcement in situations where insufficient tooth structure remains following endodontic therapy. Conventional posts are usually cast or prefabricated metal-based, requiring considerable tooth preparation of an already compromised tooth. Several FRC posts have been developed as alternatives, to support endodontically treated teeth.[4] In the present case, Super-Splint was chosen due to its superior esthetics and the need for no further tooth preparation. FRC based posts may be individually formed or prefabricated posts. Additionally, an intra-radicular ferrule effect is obtained with the use of FRC posts.[11]

Following traumatic injuries to teeth, which include sub-luxation, luxation, avulsion and root fractures, stabilization is performed with the use of splints. Dental literature includes various techniques for splinting. [12, 13] In this case report, Super-Splint was selected for its use in the splinting of multiple teeth. It is also smooth, thin, less irritating to oral soft tissues like the lip, and is considerably esthetic. However, this material has the disadvantage of being comparatively expensive.

Direct composite resin restorations can be significantly strengthened by the use of reinforcement fibers. [14] These fibers aid in the reduction of shrinkage strain and help to prevent fracture propagation. Holding the buccal and lingual cusps together with the placement of a fiber helps protect the cusps and increase the fracture resistance of the restored tooth. [15, 16] This is especially imperative in endodontically treated molars, as these teeth are frequently structurally compromised, and technical failures like de-bonding and vertical root fractures are common in the post-endodontic restoration. Visser et al postulated that the presence of fibers, either embedded in the resin itself, or placed beneath the resin, significantly improved the fracture strength of dental restoratives. [17]

Conclusion

Fiber-reinforced composites are developing as conservative and esthetic alternatives to conventional dental treatment procedures. The long-term use of these materials, however, is less known and requires further clinical studies for evaluation.

Ethical Clearance- Patient's consent was taken

Source of Funding- Self

Conflict of Interest - Nil

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