European Journal of Molecular & Clinical Medicine (EJMCM)
ISSN: 2515-8260 Volume 09, Issue 04, 2022

Original research article

Anterior Aesthetic Restorations with Fibre Bridge Reinforced

[1]Dr Roopa Patil, [2]Dr Mahantesh Patil, [3]Dr Neha Dhaded, [4] Dr Murugesh Kurani Mahadev

[1]Private Practitioner, Gadag

[2]Associate Professor, Dept. of Orthopaedics, GIMS Gadag

[3]Associate Professor, KLEVKIDS, Belgaum

[4]Assistant Professor, Dept. of Orthopaedics, Belgaum institute of Medical Sciences, Belgaum

Corresponding Author: Dr Murugesh Kurani Mahadev

Abstract
Loss of the anterior tooth may be a catastrophic event for the patient. An immediate replacement is called for especially in adolescents as it affects them both psychologically and socially. Although conventional fixed partial dentures and implant-supported restorations may often be the treatments of choice, fiber-reinforced composite (FRC) resins offer a conservative, fast, and cost effective alternative for single and multiple teeth replacement.
Keywords: FRC., FRCs, GFRC system

Introduction
The loss of anterior teeth can be psychologically and socially damaging to the patient[1]. An immediate replacement is important, to provide a positive psychological approach and to maintain the facial aesthetics and phonetics.[2] A variety of treatment modalities ranging from endosseous implants to conventional fixed partial dentures or even removable partial dentures are available for the replacement for the missing anterior teeth.[3] However, increasing demands for aesthetic and cost-effective treatment option has led clinicians to seek materials and techniques that offer conservative, minimal invasive, less time consuming alternatives. One such material is the fiber reinforced composites which offer an attractive alternative treatment for the replacement of missing anterior teeth.

Fiber-reinforced composites (FRCs) were first described in the 1960s by Smith when glass fibers were used to reinforce polymethyl methacrylate[4]. In the 1970s, carbon fibers were also used to reinforce acrylic resins[5] and, in the 1980s, similar attempts were repeated.[6,7]. In the 1990s, FRCs were used to fabricate fixed prosthodontic restorations.[8]

Over the last few years, the development of Fiber-reinforced composite (FRC) has offered the dental profession the possibility of fabricating resin bonded, aesthetically good and metal-free tooth restorations for single and multiple teeth replacement.
Three forms of pontics can be made for the FRC bridges: with natural extracted teeth, with acrylic resin teeth and by using composite resin.[2]The present paper reports a case of anterior tooth replacement done by using directly made fiber reinforced composite (GC Everstick) bridge and veneering composite crown as pontic.

Properties of fibre-reinforced polymer composites[16,20]

1.**Mechanical properties**

Geometry of the reinforcement fibers as well as fiber– resin interfaces in GFRC system affects dramatically many mechanical properties, such as strength, stiffness, toughness, static, impact and fatigue properties.
Additionally, silanization of glass fibers increases the hardness and diametric tensile. The efficiency of the fiber reinforcement varies according to fber orientation. if fibers are oriented in continuous unidirectional manner, then the reinforcing efficiency will be 1 (100%), but are only gained in one direction (Murphy 1998), while continuous bi-directional (woven, weave) fibers have reinforcing efficacy of 0.5 (50%) or 0.25 (25%) and are equal in two directions.

2. Optical properties
Glass fibers possess similar refractive index to that of resin; therefore, they allow light transmittance efficiently (Khan et al. 2015). Accordingly, addition of glass fibers to dental composite will improve their mechanical properties without affecting the degree of conversion of resin matrix, unlike opaque colored kelvin, carbon or zirconia fibers (Behl et al. 2020).

3. Viscoelastic properties
Studies revealed that the viscoelastic behavior of polymers reinforced using glass fibers was 15.32 GPa which is comparable to dentin (17GPa) (Khan et al. 2008).

4.Adhesive properties
Adhesion is an important property in dental practice, as the success of different restorative systems depends on adhesion. In a study conducted by La Bell et al., on the adhesion of titanium post, carbon fiber-reinforced posts and glass fiber-reinforced post to cements, they found that only GFRC posts showed no adhesive failure, while titanium and carbon fiber-reinforced composites posts showed 70% and 55% failure rate, respectively (Le Bell et al. 2005).

5. Thermal properties
The orientation of glass fibers has an impact on the linear coefficient of thermal expansion; linear coefficient of thermal expansion for unidirectional glass fiber was found to have an average of 5.0×10^{-6} °C^{-1} (Tezvergil et al. 2003). Interestingly, studies revealed that continuous unidirectional reinforced fbers have two coefficients of thermal expansion values, a lower value, in the direction parallel to the fbers, and a higher value, in the direction perpendicular to the fibers, as the rigidity of the fibers inhibits expansion of the matrix longitudinally and allows expansion in the transverse direction.

6. Biocompatibility

Many studies revealed that glass fiber-reinforced filling materials have low microbial adhesion to Streptococcus mutans compared to dentin and enamel (Murphy 1998). For instance, in a study conducted on Candida albicans adhesion to GFRC, it was observed that the impregnated hydrophobic resins with E-glass fibers reduced microbes' adhesion.

Use of fibre-reinforced composites[20]

1) prosthodontic applications :- it can be used in cases of broken dentures ,fixed partial dentures ,temporary crowns
2) endodontic applications :- it can be used as posts which can be prefabricated or individually polymerized posts .
3) Restoration procedures :- One of the applications of glass fiber-reinforced composite is dental restorations, short glass fibers have positive impact on polymerization shrinkage stresses of composite resin and, accordingly, on marginal microleakage; therefore, it is an ideal choice in posterior and bulk composite restorations.
4) Orthodontic applications :- An esthetic orthodontic retainer was presented as a new clinical use of GFRC. It provides high fracture strength and high adhesive bond strength to enamel and to orthodontic attachments

Procedure for preparation of fibre reinforced composite

Direct fiber reinforced composite bridge can be planned in cases such as replacing the missing canine. The treatment of such cases can be completed during a single appointment.
The required length of the FRC strip is predetermined by using a dental floss, by measuring the length from the adjacent teeth. By using the floss as a template, a piece the strip is taken from its package by using a tweezer and is cut to an equal length with scissors and placed on a clean surface to prevent contamination.

The abutment teeth is roughened by using coarse flame shaped diamond abrasives. They are then isolated, cleaned and dried .Further, they are etched (37% phosphoric acid gel), and rinsed thoroughly and gently air dried. Unfilled bonding resin is applied to the etched enamel as per the manufacturer's instructions and cured. A thin layer of flowable composite resin is placed over the prepared area on the abutment teeth prior to placing the resin impregnated fibers . The pre-cut fibre is thoroughly wetted by using the unfilled resin and adapted horizontally over the prepared area from the adjacent teeth , using a plastic filling instrument and cured. A further layer of composite is placed over the tape, ensuring that the whole tape is covered by the composite, and it was cured. The purpose of the flowable composite is to seal the space between the fibers and the enamel surface. Another piece of FRC strip is cut as per the required length of the pontic and then adapted vertical to the existing strip in order to serve as a core for building up the rest of the pontic.
The pontic can be built up layer by layer using nanohybrid-type particulate filler composite resin.The shade of final veneered composite resin is selected using a composite shade guide. The excess composite resin is removed and the occlusal interferences checked in the protrusion and the lateral excursions. The finishing and polishing procedures are carried out by using composite finishing discs and stones. Oral hygiene instructions are given to the patient.

Discussion

In cases such as Anterior edentulousness requires immediate attention for the restoration of aesthetics and function A directly fabricated FRC bridge is cost effective and a minimally invasive fixed restorative method .The clinical performance of the FRC FPDs was proven to be high, with an overall survival rate of 75% after about 5 years, which is greater than that of

FPDs with metalframeworks.9 Recent in-vitro investigations have indicated that properly designed FRC FPD can offer a higher load-bearing capacity than that of a conventional porcelain-fused to metal FPD.2

Fiber reinforcements in FRC's are made of silanated glass fibers in thermoplastic polymer and light curing resin matrix. . The fibres within the composite matrix are ideally bonded to the resin via an adhesive interface.10 The strength of these fibres is as high as that of chrome cobalt cast metal and has the advantage of not being completely rigid, but with similar modulus of elasticity to that of dentine. FRC has excellent fatigue resistance because the embedded fibres are bonded to the polymer matrix and distributed throughout the length of the prosthesis.11 The role of the fibres is to increase the structural properties of the material by preventing the crack propagation. The resin matrix acts to protect the fibres and fix their geometrical arrangement, holding them at predetermined positions to provide optimal reinforcement. The interface between the two components plays the vital role of allowing loads to be transferred from the composite used to replace missing tooth structure to the fibres.12 The abutment teeth in FRC FPDs are conserved unlike regular bridgework where almost all the enamel structure of the abutment teeth is sacrificed during the bridge preparation. From a clinical viewpoint there is a lack of long-term clinical research on FRC prostheses. However, longitudinal studies reported general failure rates between 5% and 16% over periods of upto 5 years.13,4,15 Van Heumen et al., found a survival rate of 64% after 5 years follow-up of 3-unit anterior FRC prostheses.16 Another study by F. Bohlsen and M. Kern reported a much higher failure rate of 40% over a 3-year period.17 the recent clinical data, on the semi-IPN resin matrix FRC FPDs made directly in patients mouth, suggest high survival percentages (>96% at five years), which reflects advancement in material science and techniques of fabricating FRC FPDs.18 Most common failures in FRC FPDs reported in the earlier studies were chipping off of the veneering composite in the pontic area. However current designing principles enable the clinicians to eliminate known risks for technical failures.19

Conclusion:

The procedure is highly operator-dependent and it requires an appropriate case selection and a precise technique. The combination of veneering composite, adhesive system, and FRC framework has introduced a new generation of metal-free direct teeth restorations for missing anterior teeth.Though the success in these cases is good, further studies are required to evaluate the long term success rate of the FRC bridges.

References:

1. Parolia A, Shenoy KM, Thomas MS, Mohan M. Use of a natural tooth crown as a pontic following cervical root fracture: a case report. Australian Endodontic Journal. 2010 Apr 1;36(1):35-8.
2. Khetarpal A, Talwar S, Verma M. Creating a single-visit, fibre-reinforced, composite resin bridge by using a natural tooth pontic: a viable alternative to a PFM bridge. Journal of clinical and diagnostic research: JCDR. 2013 Apr;7(4):772.
3. Akin H, Turgut M, COSKUN M. Restoration of an Anterior Edentulous Space with a Unique Glass Fiber-Reinforced Composite Removable Partial Denture: A Case Report. Journal of Esthetic and Restorative Dentistry. 2007 Aug 1;19(4):193-7.
4. Smith DC. Recent developments and prospects on dental polymer. J Prosthet Dent 1962; 12: 1066.
5. Schreiber CK. Clinical application of carbon fibre/polymer denture resin. Br Dent J 1974; 137: 21–22.
6. DeBoer J, Vermilyea SG, Brady RE. The effect of carbon fibre orientation on the fatigue

resistance and bending properties of two denture resins. J Prosthet Dent 1984; 51: 119–121.

7. Grave AM, Chandler HD, Wolfaardt JF. Denture base acrylic reinforced with high modulus fibre. Dent Mater 1985; 1: 185–187.
8. Malquarti G, Berruet RG, Bois D. Prosthetic use of carbon fibre-reinforced epoxy resin for aesthetic crowns and fixed partial dentures.J Prosthet Dent 1990; 63: 251–257
9. Vallittu PK. Survival rates of resin-bonded, glass fiber-reinforced composite fixed partial dentures with a mean follow-up of 42 months: a pilot study. J Prosthet Dent. 2004;91:241–46.
10. Vallittu PK, Lassila VP, Lappalainen R. Acrylic resin-fibre composite-Part I: The effect of fibre concentration on fracture resistance. J Prosthet Dent 1994; 71: 607–612
11. Hertzberg RW and Manson JA. Fatigue Engineering of Plastics. London: Academic Press, 1980; pp. 281–285.
12. Butterworth C, Ellakwa AE, Shortall A. Fibre-reinforced composites in restorative dentistry. Dental update. 2003 Jul 2;30(6):300-6.
13. P. K. Vallittu and C. Sevelius, “Resin-bonded, glass fiber-reinforced composite fixed partial dentures: a clinical study,” Journal of Prosthetic Dentistry, vol. 84, no. 4, pp. 413–418, 2000.
14. C. Monaco, M. Ferrari, G. P. Miceli, and R. Scotti, “Clinical evaluation of fiber-reinforced composite inlay FPDs,” International Journal of Prosthodontics, vol. 16, no. 3, pp. 319–325, 2003.
15. M. A. Freilich, J. C. Meiers, J. P. Duncan, K. A. Eckrote, and A. J. Goldberg, “Clinical evaluation of fiber-reinforced fixed bridges,” Journal of the American Dental Association, vol. 133, no. 11, pp. 1524–1534, 2002.
16. C. C. van Heumen, J. W. van Dijken, J. Tanner et al., “Five-year survival of 3-unit fiber-reinforced composite fixed partial dentures in the anterior area,” Dental Materials, vol. 25, no. 6, pp. 820–827, 2009.
17. F. Bohlsen and M. Kern, “Clinical outcome of glass-fiber-reinforced crowns and fixed partial dentures: a three-year retrospective study,” Quintessence International, vol. 34, no. 7, pp. 493–496, 2003
18. M. Özcan, Direct, Inlay-Retained, Fiber-Reinforced-Composite Restorations with Two Pontics : 5-Year Clinical Follow-Up, IADR, Toronto,Canada, 2008, Abstract 108664.
19. Garoushi S, Lassila L, Vallittu PK. Resin-bonded fiber-reinforced composite for direct replacement of missing anterior teeth: a clinical report. International journal of dentistry. 2011;2011
20. Safwat EM, Khater AG, Abd-Elsatar AG, Khater GA. Glass fiber-reinforced composites in dentistry. Bulletin of the National Research Centre. 2021 Dec;45(1):1-9.
21. Prashanth S, Subbaya KM, Nithin K, Sachhidananda S. Fiber reinforced composites-a review. J. Mater. Sci. Eng. 2017 May;6(03):2-6.