RESEARCH PAPER | Medical Science | Volume : 3 | Issue : 2 | February 2013 | ISSN - 2249-555X

Single Visit Rehabilitation with Anterior Fiber-Reinforced Resin Composite Bridges: A Review

KEYWORDS: Fiber-reinforced composite, adhesive bridge, conservative, single visit

Ambica Khetarpal	Sangeeta Talwar	Mahesh Verma
Senior Research Associate, Department of Conservative Dentistry and Endodontics, Maulana Azad Institute of Dental Sciences,New Delhi, India.	Professor and HOD, Department of Conservative Dentistry and Endodontics, Maulana Azad Institute of Dental Sciences, New Delhi, India.	Director-Principal and HOD, Department of Prosthodontics, Maulana Azad Institute of Dental Sciences, New Delhi, India

ABSTRACT *Various modalities are currently available to address the challenge of restoring a single tooth in the maxillary anterior region. These include a removable prosthesis, a conventional fixed bridge, an adhesive bridge or a dental implant. Fiber-reinforced composite (FRC) bridges are preferable if immediate and cost-effective tooth replacement is desired. This article reviews the immediate replacement of anterior teeth by single visit technique using FRC resin bridges. It is an esthetic, conservative treatment alternative and also allows for future options, if needed.*

INTRODUCTION
Loss of anterior tooth may be a catastrophic event for the patient. Immediate replacement is important to provide a positive psychological approach and to maintain facial esthetics and phonetics. Conservation, natural preservation, minimal invasion, aesthetics and cost are some of the principal factors that are considered when replacing a missing tooth. This replacement can be temporary, semitemporary or permanent in nature. FRC bridges are adhesive, minimal invasive single unit restorations that can be used for single visit replacement of missing tooth. They can act as an interim measure or a definitive prosthesis. Although several other restorative options are available like implants, fixed metal ceramic or ceramic prostheses, resin bonded fixed partial dentures (FPDs) have the chief advantage of being single appointment procedure.

The evolution of adhesive dentistry has significantly modified the concepts of traditional dentistry toward the minimal intervention approach. The FPDs were first proposed in the 70's as an alternative to traditional prosthesis. A pontic was bonded to the neighbouring teeth using acid etching and composite resin (1). These first treatments were called direct FPDs. The lost teeth could be replaced using acrylic resin teeth, extracted teeth or composite resin. These pontics were connected to the adjacent teeth with adhesive composite resins, wire, metal mesh, nylon, mesh and cast metal frameworks bonded to the adjacent teeth. (2, 3)

Clinical failures of these bridges were common as these materials could not support the repeated loading stresses during normal and para-function. Another associated problem was the overbulk of composite required to protect against breakage (4). This overbulking of the restoration led to an increase in food and plaque retention. The challenge to place a thin but strong, bonded composite resin-based single visit bridge was met with the introduction of high strength fibers that could be embedded into a resin structure. The present adhesive resin-bonded FPDs consist of a composite framework, with the pontic attached to the framework. Adjacent teeth, or abutment teeth, are usually provided with only slight preparation to create occlusal space and mechanical retention for the framework.

Advantages:
- The abutment teeth can be conserved, with little or no preparation, making this procedure truly minimally invasive and keeping the technique reversible.
- The procedure is completed at the chairside in a single visit, hence time saving.
- Cost-effective technique as it avoids laboratory costs.
- This technique can be used as an interim measure or as a permanent prosthesis.

Clinical Relevance:
The technique presented is a simple, aesthetic, cost-effective and minimally invasive way of replacing the crown of a tooth. It also provides cost effective treatment for those in the community who cannot afford conventional tooth replacement.

Use of fiber-reinforced materials in tooth replacing restorations
An advantage of fiber-reinforced composite (FRC) compared to metal resin-bonded FPDs is the tooth-colored property. An additional advantage is the less extensive work by the dental technician compared to the foundering procedures in metal ceramic restorations. The non-cured composite material is normally applied from the package directly to the construction to be made and light cured. The construction can be made on plaster casts in the laboratory, or directly in the patients' mouth (indirect vs. direct technique). Fiber-reinforced composites have a higher elasticity modulus compared to metals, resulting in lower stress in the adhesive layer. This makes FRC constructions promising.

Material composition and properties
In composites one component functions as connecting material, so-called matrix, and the other component serves to strengthen the matrix. This reinforcing component is called the filler, which can be particles or fibers. Composite is an isotropic material without specific orientation of filling particles. This means that mechanical and thermal properties of composite do not vary from different directions. A disadvantage of composite is the limited shear force strength and tensile strength. This limitation especially expresses itself when composite is applied in bridging constructions, in particular the posterior area. In bridgework a span is created, in which support of underlying tooth material is missing. As a consequence of occlusal forces, tensile stress will occur in the material. By adding filler materials with a certain orientation, such as glass fibers, aramid fibers, carbon fibers, or UHMWPE (ultra high molecular weight polyethylene) fibers to composite materials, the material becomes anisotropic. By adding fibers, high strength and stiffness is achieved in one direction of loading.

Fibers and their properties
The strength of unidirectional reinforced composite material is linked to the main orientation of the fibers, longitudinal

Volume : 3 | Issue : 2 | February 2013 | ISSN - 2249-555X

or transversal. The most used fibers (glass, carbon and polyethylene) approximately have a linear elastic behavior until fracture. They have a much higher stiffness and strength than the composite matrix. Currently, the most popular fiber types are UHMWPE and glass. Variations in dental composite reinforcement can be influenced by the type of veneering composite as well as the durability of the clinical performance of the fiber-reinforcement composite. (5,6)

UHMWPE is a linear homopolymer of ethylene with a density of 0.97 g/cm^3 and a molecular weight in the range of 3 x 106 μ to 6 x 106 μ. The use of a UHMWPE leads to a very low friction coefficient, high wear resistance, and high impact strength (7). For the UHMWPE to be chemically integrated with dental resins, they are plasma treated (4, 8) When used in dental fiber-reinforcing materials, UHMWPE is typically woven into a fabric ribbon (Ribbond® Reinforcing Ribbon, Ribbond, Seattle, WA; and Connect™, Kerr, Orange, CA)

Glass fibers are used in different forms to strengthen dental composites, including woven short and loose fibers, woven long and loose fibers, and fiber bundles (9). Woven glass-ribbon fabric and unidirectionally oriented short fibers are typically used in dentistry.

To provide for chemical integration with dental resins, the glass is silanated using the same principles used to place glass filler particles into dental composites. Untreated (not silanated) glass fibers are weaker than treated glass fibers (10). Also, glass fiber-reinforcing materials are available as resin-impregnated (pre-preg), fiber-reinforcing materials (Splint-It®, Pentron, Wallingford, CT; everStick®, Stick Tech, Turku, Finland) or non-resin impregnated (GlasSpan®, GlasSpan, Inc, Exton, PA). For laboratory use, the glass fibers frequently are embedded into composite resins and prepolymerized as rods or beams (TESCERA™, BISCO, Schaumburg, IL; Vectris™,(Ivoclar Vivadent, Amherst, NY).

Table 1: Characteristics of different fiber types

Fiber type	Brand	Fiber orientation	Pre-impregnation
Polyethylene	Ribbond DVA fibers Connect	Woven Unidirectional Bidirectional	No No No
Glass	GlasSpan Fiber-Splint Vectris Fibre-Kor Stick/ Everstick	Bidirectional Woven Woven/ Unidirectional Unidirectional Unidirectional/ Woven	No No Monomer Monomer Polymer

Karbhari and Strassler (5) tested a variety of different fiber reinforcement materials. Their conclusion was that it is crucial that the appropriate selection of fiber architectures be made not just from a perspective of highest strength, but overall damage tolerance and energy absorption. Differences in weaves and architectures can result in substantially different performance and appropriate selection can mitigate premature and catastrophic failure.

Success rate of FRC reinforced bridges

Using unidirectional glass fibers to reinforce FPDs, Valittu and Sevelius (11) evaluated 31 specimens and found a success rate of 93% at 24 months. In a 37-month follow-up of 39 FPDs made with a framework of pre-impregnated, unidirectional fiber reinforced composite, Freilich et al (12) observed a survival rate of 95%. Pjetursson (13) conducted a meta-analysis of 93 articles and reported an estimated survival rate for RBBs of 87.7% after 5 years. Failures of RBBs were most often due to debonding or recurrent caries. Piovesan et al (14) evaluated Polyethylene fiber FPDS with pontic using extracted teeth, acrylic resin teeth, or with composite resin. They found complete survival in 94.75% cases with only one case which required rebonding.

Factors influencing success rate:

a) The operator experience has been considered a significant factor to influence the success rate (15)
b) A well-designed preparation is another significant factor on resin-bonded FPD retention (15).
c) Another aspect is the potential reinforcement provided for polyethylene fibers (16). The adhesion between the fiber and the composite could increase the resistance and the hardness of the material allowing deflection without fracture (17).
d) The prosthetic space in resin-bonded FPDs is a significant factor to determine the treatment success. The distance should not be larger than 15mm, because the FPD would suffer a higher deflection and could fail. A large prosthetic space in the mandible might increase the failure rate in 3 times (18).
e) The use of additional polyethylene strips in the fabrication of the FPD and micro etching of the internal interface with aluminum oxide can also increase the resistance and mechanical adhesion with the composite resin, respectively (19).

Pontic selection

Natural tooth pontic: Using the natural tooth as a pontic offers the benefits of being the right size, shape and colour alongwith with good esthetic and functional results (20). Moreover, the positive psychological value to the patient in using his or her natural tooth is an added benefit. When the crown of the tooth is in good condition, it can be temporarily bonded easily to the adjacent teeth with light-cured restorative material. The limitation of this technique is the availability of intact natural teeth.

Acrylic resin tooth pontic: When acrylic resin teeth are used as pontic, the polyethylene fiber should be moistened using the acrylic monomer to increase bonding and resistance to fracture (21).

Composite resin pontic: It also offers good esthetic results, through the ideal stratification of the natural colors of the tooth, combining different resin shades and viscosities (19).

Other applications

- The same technique can be used as a fixed replacement following tooth loss from trauma.
- As a fixed tooth replacement in medically compromised patients who cannot sit for extended periods of time or have local anesthesia.
- For esthetic anterior periodontal tooth stabilization (22) or with periodontally compromised abutments.
- As an interim fixed restoration during implant placement and restoration (23).
- In some cases, after orthodontic treatment of the patient with congenitally missing maxillary lateral incisors, a direct-placement, fiber-splint FPD can be used to restore the missing tooth and provide for fixed orthodontic retention. This is especially pertinent for the young patient (teenager) in whom a conventional FPD or an implant is not yet indicated or practical for the given clinical situation (24).
- In orthodontics, fiber-reinforced composite resins have also been described for use a directly placed space maintainer and for fixed orthodontic retention (25).

Conclusion

Fiber-reinforced composite FPDs can satisfy the expectations of patients who seek safe, biocompatible, affordable, and esthetic restorations. However, clinicians are restricted by factors such as type of preparation, fiber frame design, span length, and the resin composite or luting agent. Most of available literature includes short-term follow-up studies. The long-term behavior of FRC bridges needs to be assessed for better understanding of their performance.

Volume : 3 | Issue : 2 | February 2013 | ISSN - 2249-555X

REFERENCE 1. Saunders WP. Resin bonded bridgework: a review. Journal of Dentistry. 1989; 17:255-65. | 2. Livaditis GJ, Thompson VP. Etched castings: an improved retentive mechanism for resin-bonded retainers. Journal of Prosthetic Dentistry. 1982; 47:52-58. | 3. Breault LG, Manga RK. The reinforced tooth pontic. General Dentistry. 1997; 45:474-476. | 4. Strassler HE, Haeri A, Gultz J. New generation bonded reinforcing materials for anterior periodontal tooth stabilization and splinting. Dental Clinics of North America. 1999; 43(1):105-126. | 5. Karbhari VM, Strassler HE. Effect of fiber architecture on flexural characteristics and fracture of fiber reinforced composites. Dental Materials. 2007; 23(8): 960-968. | 6. Ellakwa A, Shortall A, Shehata M, Marquis P. Influence of veneering composite composition of the efficacy of fiber reinforced restorations (FRR). Operative Dentistry. 2001; 26:467-75. | 7. Rose RM, Crugnola A, Reis M, et al. On the origins of high in vivo wear rates in polyethylene components of total joint prostheses. Clinical Orthopaedics and Related Research. 1979; 145:277-286. | 8. Rudo DN, Karbhari VM. Physical behaviors of fiber reinforcement as applied to tooth stabilization. Dental Clinics of North America. 1999; 43(1): 7-35. | 9. Hull D. Fibers and matrices. In: Hull D, Clyne TW, eds. An Introduction to Composite Materials. 2nd edition. Cambridge, UK: Cambridge University Press; 1996; 9-38. | 10. Solnit GS. The effect of methyl methacrylate reinforcement with silane treated glass fibers. Journal of Prosthetic Dentistry. 1991; 66(3):310-314 | 11. Vallittu PK, Sevelius C. Resin-bonded, glass fiber-reinforced composite fixed partial dentures: a clinical study. Journal of Prosthetic Dentistry. 2000; 84:413-8. | 12. Freilich MA, Meiers JC, Duncan JP, Eckrote KA, Goldberg AJ. Clinical evaluation of fiber-reinforced fixed bridges. Journal of American Dental Association. 2002; 133:1524-34; quiz 40-1. | 13. Pjetursson BE. A systematic review of the survival and complication rates of resin-bonded bridges after an observation period of at least 5 years. Clinical Oral Implants Research 2008; 19: 131-141. | 14. Piovesan EM, Demarco F, Piva E. Fiber-reinforced fixed partial dentures:a preliminary retrospective clinical study. Journal of Applied Oral Sciences. 2006; 14(2):100-4. | 15. Djemal S, Setchell D, King P, Wickens J. Long-term survival characteristics of 832 resin-retained bridges and splints provided in a post-graduate teaching hospital between 1978 and 1993. Journal of Oral Rehabilitation. 1999; 26:302-20. | 16. Kau K, Rudo DN. A technique for fabricating a reinforced composite splint. Trends & techniques in the contemporary dental laboratory. 1992; 9:31-3. | 17. Nash RW. Reinforced composite resin: a restorative alternative. Compendium. 1994; 15:554, 7-60. | 18. Creugers NH, De Kanter RJ, Verzijden CW, Van't Hof MA. Risk factors and multiple failures in posterior resin-bonded bridges in a 5-year multi-practice clinical trial. Journal of Dentistry. 1998; 26:397-402. | 19. Fahl N, Jr. Restoration of the maxillary arch utilizing a composite resin buildup and a fiber framework. Practical Periodontics & Aesthetic Dentistry.1998; 10:363-7. | 20. Belli S, Ozer F. A simple method for single anterior tooth replacement. Journal of Adhesive Dentistry. 2000; 2:67-70. | 21. Hannon SM, Breault LG, Kim AC. The immediate provisional restoration: a review of clinical techniques. Quintessence International. 1998; 29:163-9. | 22. Vineet Kini, Sanjiv.M. Patil, Rasika Jagtap. Bonded Reinforcing Materials for Esthetic Anterior Periodontal Tooth Stabilization: A Case Report. International Journal of Dental Clinics. 2011:3(1): 90-91 | 23. Meiers JC, Freilich MA. Use of a prefabricated fiber-reinforced composite resin framework to provide a provisional fixed partial denture over an integrating implant: a clinical report. Journal of Prosthetic Dentistry. 2006; 95(1): 14-18. | 24. Trushkowsky R. Fiber reinforced composite bridge and splint. Replacing congenitally missing teeth. NewYork State Dent Journal. 2004; 70(5): 34-38. | 25. Karaman AI, Kir N, Belli S. Four applications of reinforced polyethylene fiber material in orthodontic practice. The American Journal of Orthodontics and Dentofacial orthopedics. 2002; 121(6):650-654. |