Various options are currently available in clinical practice for the replacement of a single missing tooth. For many years, metal-ceramic fixed dental prostheses (FDPs) have been the treatment of choice for this purpose, and recently, all-ceramic FDPs have been recommended. For metal-ceramic and all-ceramic FDPs, aggressive tooth reduction is necessary to provide both retention and stability. The development of implant-supported restorations has facilitated a more conservative approach to the replacement of a single missing tooth. However, the need for a surgical procedure and its relatively high cost may mean that implant therapy is not appropriate for all patients. In these situations, a resin-bonded FDP may provide an alternative treatment option.

Traditionally, resin-bonded FDPs have been constructed from porcelain bonded to a nonprecious metal framework, cemented with a chemically active resin. Fiber-reinforced composite resin (FRC) now represents a lower-cost alternative to traditional metal-ceramic for the construction of resin-bonded prostheses. Two case reports illustrate the use of FRC prostheses as fixed semipermanent restorations. (Quintessence Int 2010;41:471–477)

Key words: composite resin, fiber-reinforced, fixed partial denture, fixed prosthesis, provisional
Recently, however, there have been considerable advances in fiber-reinforcement technology.\textsuperscript{12} The most commonly used FRCs consist of glass fibers embedded in a dimethacrylate resin matrix.\textsuperscript{4,5,9,13} An alternative system is based on the use of a multiphase polymer matrix of linear polymer with a dimethacrylate resin.\textsuperscript{10,14} A multiphase polymer matrix of FRC is proposed to improve adhesion between the veneering composite and composite luting agent to the FRC framework.\textsuperscript{15,16}

FDPs constructed from FRC may be retained using complete-coverage crowns, inlays, surface-retained wings, or a combination. The use of full-coverage retainers has been recommended;\textsuperscript{17} however, the preparations required for these are as extensive as those required for metal-ceramic reconstructions. In current clinical practice, FRC-FDPs are most commonly surface- or inlay-retained to minimize the need for tooth preparation.

Several authors have reported on the clinical performance of FRC-FDPs. In a systematic review including 15 clinical studies of FRC-FDPs, van Heumen et al\textsuperscript{17} reported the Kaplan-Meier estimate of overall survival to be 73.4\% at 4.5 years. A more recent study by van Heumen et al\textsuperscript{18} evaluated the outcome of three-unit anterior FRC-FDPs and reported a similar survival rate of 64\% after 5 years.

The following two clinical reports illustrate the use of FRC-FDPs with preimpregnated glass fibers and composite resin to replace missing teeth. These cases are intended to illustrate indications for FRC-FDPs.

**CLINICAL REPORT 1**

A 29-year-old woman presented with a missing maxillary right first molar (Fig 1). Following radiographic evaluation and occlusal analysis, the patient was offered several treatment options. The patient rejected placement of a single-tooth implant because of the length of time required for treatment. Likewise, a conventional FDP was refused because both potential abutment teeth were sound. Examination of the occlusion revealed favorable conditions (absence of bruxism, good occlusal stability, and the presence of all remaining teeth). The patient selected a conservative approach to restore the missing molar utilizing a FRC-FDP.

The abutment teeth were prepared using conventional diamond, tapered, rounded-end burs (Brasseler). The preparations consisted of removing approximately 1.0 mm of enamel on the lingual and proximal aspects of abutment teeth (partial wraparound). Occlusal reduction of 2 mm was required to ensure adequate space for placement of the fibers and composite resin. Approximately one-third of the palatal surface was included in the preparation. All gingival margins were in enamel, chamfered and supragingival. The internal line angles were rounded, and the gingival floor was prepared with a butt joint (Fig 2). Following completion of the preparation, a polyether (Impregum, 3M ESPE) full-arch impression and an opposing alginate impression were taken with appropriate occlusal registrations (Arcus, KaVo). The
preparations were provisionally restored with light-cured methacrylate material (Fermit, Ivoclar Vivadent). Before light curing, an everStick fiber bar (Stick Tech) was placed into the Fermit to act as a space maintainer. The impressions were cast in die stone, and the casts were mounted on a semiadjustable articulator using a facebow.

The FRC-FDP was fabricated using preimpregnated, unidirectional E-glass fiber reinforcements (Stick, Stick Tech), which were further impregnated with light-polymerizable resins (Sinfony Activator Liquid, 3M ESPE). The fabrication process followed the recommendations proposed by Vallittu and Sevelius. Veneering was completed using a microhybrid composite resin (Sinfony, 3M ESPE).

The final restorations were cemented within 7 days of preparation. Following removal of the provisional restoration, rubber dam was placed and the prepared tooth surfaces were cleaned using intraoral airborne-particle abrasion (50-μm aluminum oxide powder, Hager and Werker) for approximately 5 seconds (Fig 3). The inner surfaces of the FRC-FDP retainers were coated with the bonding agent Stick Resin (Stick Tech) and left for 5 minutes. The prepared surfaces of the abutments were etched with 35% phosphoric acid gel (Ultra-Etch, Ultradent) for 20 seconds and subsequently rinsed and air dried. A dentin adhesive system (Scotchbond Multi-Purpose, 3M ESPE) was used in conjunction with the luting cement (Panavia, Kuraray), and the restoration was slowly seated with gentle finger pressure. Excess cement was removed with the tip of an explorer previously loaded with unfilled adhesive resin (Stick Resin) (Fig 4). The restoration was cured after all the margins were covered with a layer of glycerin gel (Oxyguard, Kuraray) to prevent oxygen inhibition during polymerization.

For each of the abutments, the buccal, occlusal, and palatal aspects were light cured for 60 seconds at greater than 850 mW/cm² (Optilux 501, Kerr/Dematron). Following rubber dam removal, occlusal adjustment was performed to ensure that light occlusal contact was present in the maximal intercuspal position, with no contact on lateral or protrusive excursion. Finishing was performed using Sof-Lex disks and Profin tips (W&H), and final polishing was performed with diamond paste (Shiny A, Micerium) (Fig 5).
A 15-year-old patient presented following orthodontic therapy with missing maxillary lateral incisors (Fig 6). Following discussion with an implant dentist, a conservative approach was proposed to replace the missing teeth using FRC-FDPs, as the patient was too young for implants, with the possibility of implant therapy reserved as a future treatment option.

Diagnostic casts were mounted on a semiadjustable articulator to plan the preparations ensuring minimal tooth tissue removal. The preparations consisted of removing approximately 1.0 mm of enamel on the palatal and proximal aspects of the abutment teeth (Fig 7). After the preparation was outlined, rubber dam was placed, and a 35% phosphoric acid gel (Ultra-Etch) was applied to the prepared surface for 20 seconds. The teeth were then rinsed and gently dried. Scotchbond Multi-Purpose was applied to the preparations following the manufacturer’s instructions. All gingival margins were in enamel, chamfered and supragingival. The internal line angles were rounded, and the gingival floor was prepared with a butt joint. Impressions, occlusal registration, and provisional restorations were similar to those in the previous case report, with care taken to ensure a provisional space maintainer was provided because the patient had recently completed orthodontic therapy.

The final restoration was cemented according to the protocol described for the case above with the exception of the luting cement used. Instead of conventional luting cement, a light-cured microhybrid composite resin Valux Plus (3M ESPE) was used. Light polymerization of the cement enables the working time to be extended and facilitates removal of excess cement. The first step in the final placement of the restoration was to apply one coat of adhesive resin to the tooth, followed by gentle air thinning and light curing. From that moment on, the working field was kept free from intense light (chairside lamp or others) to prevent premature curing of the microhybrid composite. The FRC-FDP restorations were slowly seated as described in the previous case report, and
any gross excess of cement was eliminated. Continuous pressure was maintained on the restoration during initial light curing, 5 seconds for each abutment. Polymerization of the marginal area was performed after all the margins were covered with a layer of glycerin gel (Kuraray) to prevent oxygen inhibition during polymerization. Polymerization, finishing, and polishing procedures were similar to those described in case report 1. Occlusal adjustment was performed to ensure no heavy contacts on the restoration during protractive and lateral excursions. The appearance of the cemented restorations can be seen in Figs 8 and 9.

**DISCUSSION**

These case reports illustrate the use of FRC-FDPs to restore missing anterior and posterior single teeth. Minimal preparation was performed in both cases, as it has been suggested that FRC-FDPs perform better when teeth have been prepared. To date, few studies have focused on tooth preparation, and the principles governing tooth preparation have yet to be established fully.

The preparations for the cases presented were both minimal and confined to enamel; however, in some cases, removal of existing intracoronal restorations may be necessary as part of the preparation, leading to exposure of dentin. Burrow et al have reported that current resin luting cements produce relatively weak bonds to dentin compared with current dentin bonding systems for direct composite resin restorations. Consequently, a resin-coating technique has been suggested for cases in which preparations for resin-retained restorations extend into dentin. This technique involves the application of a dentin bonding agent and a thin layer of flowable composite resin onto the exposed dentin. The preparation margins are then redefined before impression taking to ensure sound enamel margins.

The aim of this technique is to create an optimal hybrid layer and resin film on the dentin surface and maximize adhesion between dentin and the resin cement. Jayasooriya et al reported that the application of a resin-coating technique improves the interfacial adaptation of indirect composite restorations during cementation. Additionally, De Goes et al reported that the early bond strength of a resin cement, Panavia F
Zarow et al (Kuraray), was significantly improved by the application of a resin-coating technique.\textsuperscript{24} It is therefore suggested that a resin-coating technique could be a useful method for preventing reductions in bond strengths between dentin and FRC-FDPs; however, further research is necessary to establish this. A further benefit of applying a resin coating immediately following tooth preparation is that the prepared tooth surface is sealed to protect the pulp from mechanical trauma, thermal stimuli, and, most importantly, bacterial invasion during impression taking, provisional restoration fabrication, and final cementation procedures.\textsuperscript{23}

Where a resin coating technique is employed, it is important to clean the tooth surface before cementation of the restoration to enhance adhesion of the luting agent to the preexisting resin layer.\textsuperscript{25,26} A pumice slurry has been suggested as a means of removing remnants of provisional cements,\textsuperscript{27} although its efficacy has been questioned.\textsuperscript{28} Another proposed, fast and effective final cleansing method is the use of intraoral airborne-particle abrasion. In a recent study by Fonseca et al,\textsuperscript{29} higher bond strength values for indirect resin restorations were achieved when abrasion with 50-µm aluminum oxide was used in this way.

In the second case, a novel luting technique was employed whereby a light-polymerizable hybrid composite resin was used instead of a conventional dual-cure resin luting cement. Magne et al\textsuperscript{30} have reported on the successful use of light-polymerizable hybrid composite resin for cementation of anterior porcelain veneers. In contrast with conventional fixed partial dentures, FRC-FDPs with minimal tooth preparation may be displaced during cementation. The use of a higher viscosity luting material such as a hybrid composite resin may improve stability during removal of excess cement.

Another potential problem with dual-cure composite resin cements is color instability due to amine degradation associated with chemically activated polymerization.\textsuperscript{31} Besek et al\textsuperscript{32} have demonstrated that dual-cured resins have no advantage over solely light-polymerizable products with respect to conversion, provided that each proximal restored surface is cured for at least 120 seconds in a regular curing mode.

These two reports illustrate the use of FRC-FDPs as long-term semipermanent restorations. Although the expected lifespan of these restorations is limited compared to conventional fixed prostheses, they represent a lower-cost fixed option compared with traditional metal-ceramic resin-retained prostheses. Their use may be particularly indicated to replace missing teeth and maintain space in cases where patients have completed orthodontic treatment but are too young to embark on implant therapy.

**CONCLUSION**

The novel application of fiber-reinforced composite resin for use with fixed prostheses is an exciting innovation. However, evidence-based guidelines for clinical indications, prosthesis design, and tooth preparation are required along with information regarding longevity. Application of a resin-coating technique and light-polymerizable hybrid composite resin for cementation could be a promising innovation in clinical dental practice.

**REFERENCES**


