USE OF A CAD/CAM-FABRICATED GLASS FIBER POST AND CORE TO RESTORE FRACTURED ANTERIOR TEETH: A CLINICAL REPORT

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Prefabricated glass fiber posts are widely used; however, their shape cannot be changed and they can be unsuitable for severely damaged teeth with wide root canals. This clinical report describes a procedure for restoring a severely damaged anterior tooth with a customized 1-piece glass fiber post and core, fabricated using a CAD/CAM system. This 1-piece glass fiber post and core adapts better to the root canal than a prefabricated glass fiber post, and reduces the cement layer thickness. Furthermore, it does not require the use of a composite resin foundation. (J Prosthet Dent 2010;103:330-333)

When restoring severely damaged teeth, a cast metal post and core is traditionally used to provide the necessary retention for a subsequent restoration. According to a 10-year retrospective study by Balkenhol et al,[1] the fit of a cast post and core to the post space significantly influences the survival probability. Prefabricated glass fiber posts have good mechanical and biocompatibility properties[2,3] and a desirable shade. However, their diameters cannot be customized to adapt to individual post space preparations. Furthermore, most glass fiber posts need a separate composite resin core, and the weak interface between the resin core and fiber post may cause a higher restoration failure rate.[4]

The long-term failure rate of fiber posts reportedly ranges from 7 to 11%.[5] Apart from endodontic problems, the primary reasons for failure include crown dislodgement and post debonding. Mechanical failures are often related to the fragile coronal portion of the post and core and the weak bonding interface between the post space preparation and the post. Because the epoxy resin matrix of the fiber post is highly cross linked,[6,7] the composite resins used for core foundations and the cement materials do not form tight chemical bonds with the fiber post surface. The establishment of reliable bonds at the root-post-core interfaces is critical for the clinical success of a post-retained restoration.[4]

In addition to the conventional cast metal post and core and prefabricated fiber posts, there are additional methods for restoring severely damaged teeth. These include use of zirconia post and cores fabricated using computer-aided design/computer-aided manufacturing (CAD/CAM) technology,[8] adhesively bonded polyethylene fiber-reinforced composite resin posts,[9] or reinforcement of the root canal inner wall with resin-bonding techniques.[10] Alternatively, a 1-piece post and core can provide good adaptation in the post space, as well as provide a structure that lacks a post-and-core interface.

Some authors indicate that the materials used to restore endodontically treated teeth should have physical and mechanical properties similar to dentin.[11] The elastic modulus of glass/quartz fiber-reinforced composite resins is approximately 30-40 Gpa, which is close to that of dentin (18.6 Gpa). Gold alloy, titanium, and carbon fiber-reinforced composite resins have higher elastic moduli (80-120 Gpa) compared to dentin; the elastic modulus of steel or zirconia (170-210 Gpa) is so high that it may cause root fracture.[3,12-14]

The glass fiber block described in this report is made of an epoxy polymer matrix appropriate for milling, as the fibers remain together during the milling process, and the manufacturer purports that the modulus is similar to that of fiber-reinforced composite resins. The 1-piece glass fiber post and core was milled with this glass fiber block by scanning the wax pattern, which was then processed using a CAD/CAM system. This clinical report describes a method for restoring a fractured anterior tooth with a 1-piece glass fiber post and core milled using CAD/CAM technology.

Presented at the 50th Anniversary of the Korean Academy of Prosthodontics International Prosthodontic Congress and the 6th Biennial Congress of the Asian Academy of Prosthodontics (AAP), Seoul, Korea, April 2009.

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1 Fractured maxillary left central incisor.


2 Radiograph of fractured tooth.

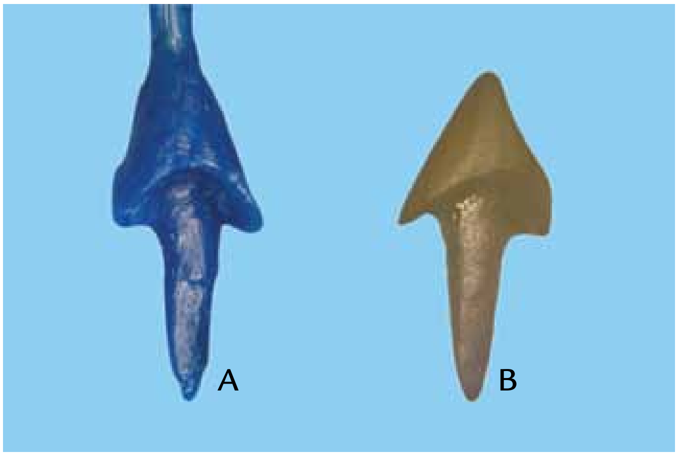
CLINICAL REPORT

A 26-year-old Asian man presented to the prosthodontic department of the School and Hospital of Stomatology at Peking University, Beijing, China, for endodontic treatment, with the chief complaint of a fractured left maxillary central incisor. The coronal portion of the incisor was missing (Fig. 1). Radiographic examination indicated successful endodontic treatment with a relatively wide root canal (Fig. 2). The remnants of the incisor were measured with a periodontal probe, revealing a 3-mm-wide root canal orifice and a 1-mm ferrule located only on the labial surface.

Use of a conventional prefabricated glass fiber post was not an option, as the post diameter would not allow for good adaptation to the post space, and the resulting thick cement layer would affect the bond strength, increasing the risk of mastication-induced fracture. The inadequate ferrule did not provide adequate support for a composite resin core. Although a conventional cast metal post might have been used to restore the incisor, a stainless steel post and core would be too rigid and could increase the risk of root fracture.[15,16] A cast gold post and core would be the conventional restoration method for this situation, but the metal color would affect the translucency of a subsequent ceramic restoration. Given these challenges, a CAD/CAM-fabricated glass fiber post and core and a ceramic crown were planned to restore the tooth.

The root canal was prepared with a low-speed instrument (Peeso Reamers; Mani, Inc, Utsunomiya, Japan). To gain adequate length and diameter for the glass fiber post and core, a portion of gutta-percha was removed to a depth of approximately 8 mm; the diameter at the cervical portion was 3 mm. The post space was prepared to eliminate undercuts because it was already relatively wide. The edge of the root orifice was rounded with a high-speed extra-fine diamond rotary cutting instrument (Dia-Burs, TR-13EF; Mani, Inc) to facilitate the scanning and milling process. An impression of the post space and adjacent teeth was made using vinyl polysiloxane (Flexitime; Heraeus Kulzer GmbH, Hanau, Germany) which was cast in type IV high-strength die stone (Royal Rock; Pemaco, Inc, St. Louis, Mo). From the cast, a wax (Casting Wax Bar; Shanghai Medical Instruments Co, Ltd, Shanghai, China) pattern of the post and core was made without sharp edges to facilitate scanning (Fig. 3, A). The wax pattern was digitized with a 3-dimensional (3-D) scanner (SmartVision; Gimmafei Technology Development Co, Ltd, Beijing, China), and the data were processed using CAD/CAM software (Capture1.0; Gimmafei Technology Development Co, Ltd). A digital 3-D model of the post and core was developed. A prefabricated, composite resin-wrapped, glass fiber block (Ouyaruikang New Material Science and Technology Co, Ltd, Beijing, China) was milled to develop the post and core (Fig. 3, B) with a milling machine (VMC 850s; She Hong Industrial Co, Ltd, Taichung, Taiwan).

After milling, the fiber post and core was wrapped with red, 8-μm-thick articulating paper (Arti-Fol; Dr Jean Bausch KG, Cologne, Germany) and placed into the post space to evaluate fit. After removal, interferences were relieved using a finishing diamond rotary cutting instrument (Dia-Burs, TR-13EF; Mani, Inc) in a high-speed handpiece (W&H Synea HS, TA-98; W&H Dentalwerk Bürmoos GmbH, Bürmoos, Austria). When the fiber post and core was completely seated in the root canal,



3 Post and core. A, Wax pattern. B, Milled post and core.

4 Tooth preparation completed.

5 Incisor restored with ceramic crown.

6 Radiograph of incisor after 8 months.

the core portion was modified slightly for definitive crown preparation. The root canal was cleaned with 75% alcohol to eliminate remnants of the articulating paper and air dried. The post and core was rinsed with ultrasonic cleaner (VS 350; Silfradent Srl, Santa Sofia, Italy), and then the bonding surface was conditioned (Super-Bond C&B Monomer; Sun Medical Co, Ltd, Moriyama, Japan). The post and core was cemented into the root canal using a resin cement (Super-Bond C&B; Sun Medical Co, Ltd), according to the manufacturer's instructions. After the resin cement was polymerized, the tooth was prepared for a ceramic crown by placing a 1-mm shoulder and a 1-mm ferrule around the entire tooth (Fig. 4). The incisor was restored with a ceramic crown (Procera Alumina; Nobel Biocare AB, Göteborg, Sweden) (Fig. 5). The patient was recalled 8 months after the 1-piece glass fiber post and core was cemented, and no complications were noted. A periapical radiograph demonstrated that the fiber post and core remained well adapted to the post space (Fig. 6).

DISCUSSION

Interest in glass fiber-reinforced composite materials has increased over the last 10 years.[6] Although most glass fiber posts are prefabricated and, therefore, do not fit all root canals, prefabricated fiber posts require a composite resin foundation. With the aid of CAD/CAM technology, a glass fiber post-and-core system can be created as a 1-piece structure that fits any tooth. When restoring a severely damaged clinical crown with a wide post space, the 1-piece glass fiber post and core can be well adapted and reduce the cement layer thickness. The modulus of the 1-piece glass fiber post and core is similar to that of dentin, which limits stress concentration in the weakened root canal. According to in vitro studies, the failure load of prefabricated glass fiber posts is about 75.9 kg (ParaPost Fiber White, 1.7 mm; Coltène/Whaledent, Inc, Cuyahoga Falls, Ohio)[16] and 534.7 N (Snowpost, 1.6 mm; Abrasive Technology, Inc, Westerville, Ohio),[17] which is greater than the masticatory force of maxillary central incisors.[18] The CAD/CAM-fabricated 1-piece glass fiber post and core was thicker than prefabricated fiber posts, and can be expected to withstand masticatory forces. The translucency of the core is compatible with ceramic crowns. The primary disadvantages of the CAD/CAM-fabricated glass fiber post and core are its relatively complex production process and that it requires 2 treatment sessions.

The fractured incisor described in this report had a 3-mm-wide open orifice, with no coronal portion of the tooth remaining. Use of a prefabricated fiber post was therefore not ideal, and a CAD/CAM-fabricated 1-piece glass fiber post and core was used with satisfactory results. The glass fiber block was made of an epoxy polymer matrix appropriate for milling that kept the fibers together during the milling process. The manufacturer purports that the flexural modulus of this material is 25.0-45.0 Gpa. The CAD/CAM system used contains a raster scanner (SmartVision; Gimmafei Technology Development Co, Ltd), 3-D model-processing software (Capture1.0; Gimmafei Technology Development Co, Ltd), and a 4-axis milling machine (VMC 850s; She Hong Industrial Co, Ltd, Taiwan, China). This system is designed specifically for dental restorations and is compatible with dental materials.

Super-Bond C&B (Sun Medical Co, Ltd), which was used as the luting cement, contains 4-META bonding monomers that enhance the bonding between the root canal dentin and glass fiber posts.[19] The slow polymerization process of Super-Bond C&B (Sun Medical Co, Ltd) helps to release shrinkage stress.[20] As the retention form of the post was rather limited, a strong luting material was needed.

SUMMARY

This clinical report describes a method for restoring a fractured anterior tooth with a 1-piece glass fiber post and core milled with CAD/CAM technology. Using this method, the post and core fits into a prepared post space more precisely than would a prefabricated fiber post. The milled post and core is also thicker than a prefabricated fiber post, and the core portion is reinforced by the glass fiber.

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Acknowledgements
The authors thank Prof Xiao-ping Yang of the key laboratory for the preparation and processing of novel polymer material at the Beijing University of Chemical Technology, and for providing the prefabricated glass fiber block. The authors also thank Can Liu and Xing Wu of Gimmafei Technology Development Co, Ltd, Beijing, China, for providing CAD/CAM technology.