CASE REPORT

Computer-aided Design Computer-aided Manufacturing Fabricated Polyetheretherketone Post and Core Restoration

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ABSTRACT

Biocompatible high-performance polymers, polyetheretherketone (PEEK), were introduced as novel dental materials. Due to their acceptable fracture resistance, shock-absorbing ability, and better stress distribution, high-performance polymers are considered as alternative dental materials for metal and glass ceramics. This is important in the restoration of extensively damaged upper central incisor with esthetic concern. Long-term clinical evidence is required before recommending the application as a substitute material.

Key words: CAD, CAM, Polyetheretherketone, Post and core restoration

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INTRODUCTION

Intraradicular dental post and core systems have been extensively used for the restoration of teeth that have lost a substantial amount of their crown structure.[1,2] Traditionally, metal alloy post and core systems are preferably chosen for the restoration of the tooth in such status, because they are easily custom-built to the various shapes of the root canal and have excellent mechanical strength.[3] However, due to a large elastic modulus disparity between metal alloys and dentine, an unwarranted functional stress concentration may occur around the post, resulting in root fracture.[1,2,4] Therefore, to achieve long-term safety, numerous post and core materials have been investigated. According to previous studies, when using a lower elastic modulus post material, such as fiberglass, a more favorable stress distribution ensues.[5-12] However, since fiberglass posts are generally supplied as ready-made products, they are limited in terms of their conformity to the shape of the root canal. In addition, although fiberglass posts have lower elastic moduli (from 45.7 to 53.8 GPa)[13] than those of metal alloy posts (110.0 GPa for titanium and 95.0GPa for gold),[14] these are still approximately 3 times the elastic modulus of dentin (18.6 GPa).[15]

Recently, biocompatible high-performance polymers, polyetheretherketone (PEEK), were introduced as novel dental materials. Due to their acceptable fracture resistance, shock-absorbing ability, and better stress distribution, high-performance polymers are considered as alternative dental materials for metal and glass ceramics.[16] PEEK is one of the organic thermoplastic polymers in the PolyArylEtherKetone (PAEK) family, best-known as a high-performance polymer family, and mainly serves as an implantation material due to its above-mentioned features and good biocompatibility in the medical field.[17] It has been recognized as an adequate alternative biocompatible material for long-term proven titanium in orthopedic applications.[18] In the dental area, the main usage of the PAEK family has increasingly been as temporary implant abutments.[19] In addition, it is used as dental clasps and frameworks for removable dental partial prostheses. The manufacturer (Cendres+Metaux, Milano, Italia) reports that PEEK has a similar compressive strength (246 MPa) to that of dentin (297 MPa),[14] although it has a lower elastic modulus (5.1 GPa) than that of elastic modulus (30 GPa) of dentin. In addition to its biocompatibility, appropriate mechanical strength, shock-absorbing ability, and a wide capability of fabrication processing including milling and pressing make PEEK an attractive dental material for the fabrication of custom-made intraradicular dental post-core systems. According to the previous studies,[17] PEEK can also be used in resin bonding systems with an appropriate combination of mechanical surface treatments and primers. However, there have been no studies of this novel high-performance polymer PEEK as post-core material. In this case, report endodontically treated tooth with the excessive coronal loss was restored with computer-aided design (CAD) computer-aided manufacturing (CAM) PEEK post and core and zirconium crown.

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CASE REPORT

A 21-year-old male patient reported to the Department of the Prosthodontics, Crown, and Bridge, K. M. Shah Dental College and Hospital, Sumandeep Vidyapeeth, Piparia, Vadodara, with a chief complaint of loosening of the anterior restoration [Figure 1]. Based on the patient's esthetic requirement, considerations of remaining coronal tooth structure and occlusion, a decision of removal of old restoration [Figure 2] was made followed by post-endodontic restoration with a CAD/CAM-fabricated PEEK post-core was reached. Informed consent of the patient was obtained after the nature of the procedure, and possible discomforts and risks had been explained.

Old porcelain fused to metal prosthesis which was fabricated 8 years back was removed [Figure 3], and pre-operative IOPA was taken [Figure 4]. The coronal portion of the teeth contained a metal post which was removed using an ultrasonic scaler tip. To record the anatomies of the canals, the plastic posts (Spee Dee Plastic Pins; Pulpdent Corp, Watertown, USA) were

Figure 1: Profile view

Figure 2: Pre-operative view

Figure 3: After removal of prosthesis

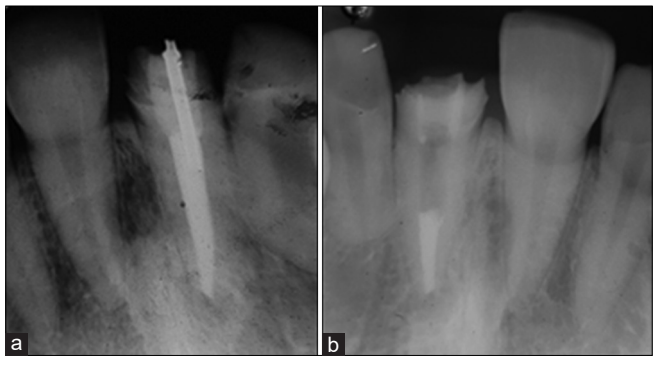

Figure 4: a) Intraoral Radiograph showing an Post, b) After removal of Post

Figure 5: Endodontic post fabrication using pattern resin

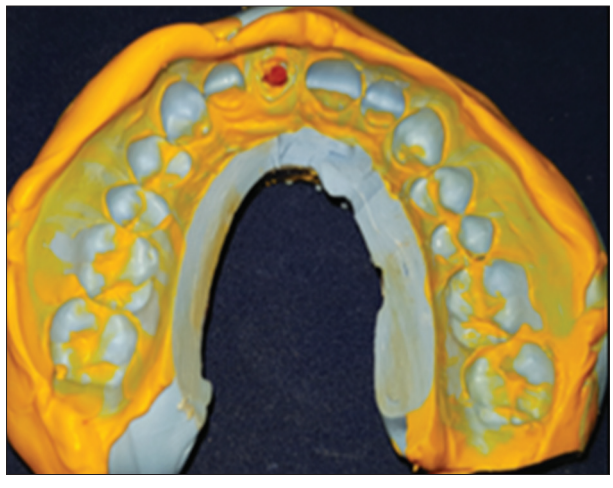

Figure 6: Final impression

covered with autopolymerizing pattern resin LS (GC Pattern Resin; GC Corp, New York, USA) and then inserted into the canals [Figure 5]. The posts were kept in position for a few seconds and then quickly removed to check their accuracy. To prevent the posts from getting stuck in the canal, the posts were continuously moved in and out of the canal until they were completely polymerized. The post patterns were placed in the canals, and the cores were built using pattern resin LS. The teeth and the polymerized post and cores were finished using diamond rotary cutting instruments to minimize tooth preparation [Figure 6].

The post and core pattern was scanned digitally and was milled from a PEEK block (Zirkonzahn, Switzerland) [Figure 7]. Exact post and core pattern were produced by the CAM system [Figure 8]. Later, the pattern was put in the sintering furnace. The sintering process was completed at 1430°C in approximately 6 h. Following the sintering, the fit of the PEEK post and cores with the teeth was controlled [Figure 9], and they were cemented using dual-cure resin cement (Variolink II, Ivoclar Vivadent, and Schaan/Leichtenstein) [Figure 10]. For the cementing process, 37% orthophosphoric acid (total-etch technique) was applied inside the canals and cleaned after 30 s [Figure 11]. Surface treatment of PEEK comprised etching with 98% sulfuric acid for 60 s. Enamel and dentin bonding (Syntac Primer - Syntac Adhesive) system was applied as prescribed by the manufacturer. The transparent adhesive resin cement base and catalyst pastes (Variolink II, Ivoclar Vivadent, and Schaan/Leichtenstein), mixed in a 1:1 ratio in accordance with the manufacturer's instructions, were applied and the excess was overflowed [Figure 12]. The excess cement was removed with the help of a probe and irradiated for a period of 40 s in each direction. To fabricate zirconia-based crowns, impressions were taken using silicone-based materials. Crowns were manufactured with the same CAD/CAM procedure used for the PEEK-based post and cores. After both the marginal fit and the internal fit, occlusal and proximal contacts were examined during the try in. The all-ceramic crown was treated with Ivoclean then cemented with the dual-cure resin cement (Variolink II, Ivoclar, Vivadent, and Schaan/Leichtenstein) [Figure 13].

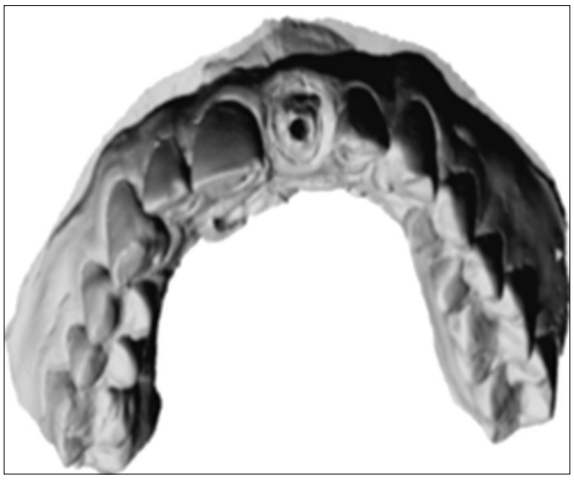

Figure 7: Scanned image of impression

DISCUSSION

This case report utilised the high-performance polymer PEEK as an intraradicular post-core material. For a post and core restored endodontically treated tooth, a root fracture is an undesirable incident. According to previous studies, one of the causes of root fracture of post-restored teeth is stress concentration around the post-apex.[1-3] Clinically, when a high elastic modulus metal post and core is used as an intraradicular post and core in endodontically treated teeth, vertical root fractures often occur, which then lead to extraction of the teeth. To prevent catastrophic vertical root fracture, a prefabricated fiberglass post and resin core is currently being used as a post and core system.[19] Since fiberglass has a lower elastic modulus than metal but similar strength, fiberglass post systems induce favorable stress distributions within the root and generally exhibit a repairable horizontal fracture mode when root fracture occurs. However, while fiberglass has a lower elastic modulus than metal, its elastic modulus is still several times higher than that of dentine. Recently, the high-performance polymer PEEK with an elastic modulus lower than that of fiberglass and similar to that of dentine has been introduced as an alternative intraradicular post-core material. However, there have been no experimental and clinical studies on the

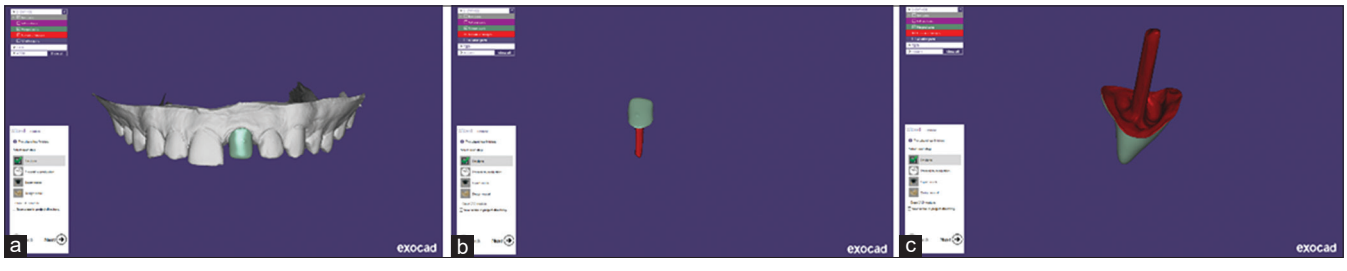

Figure 8: a) Cad/Cam designed post, b) Evaluating the length of post, c) Evaluating the intaglio surface of post

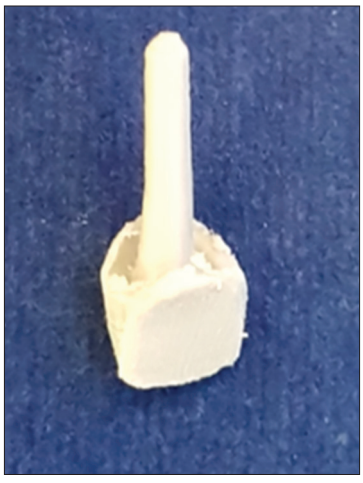

Figure 9: Post milling image of Post made from PEEK blocks

Figure 12: Surface treatment of crown

Figure 10: Cementation of the post

Figure 13: Post-cementation image of prosthesis

Figure 11: Armamentarium for cementation of all ceramic crown

use of this material as a post-core system.[16-19] During intraoral try-in, the contamination of restoration surfaces with saliva cannot be avoided. However, this contamination can pose a problem when the lab-fabricated restorations are adhesively cemented afterward. The cleaning of saliva-contaminated restoration surfaces with phosphoric acid gel is only unproblematic when glass-ceramic restorations are involved. Due to the surface-deactivating effect of phosphoric acid, this cleaning method cannot be used in conjunction with zirconium oxide ceramics and base metal alloys.

Ivoclean allows effective cleaning of the saliva-contaminated bonding surfaces of restorations. Ivoclean consists of an alkaline suspension of zirconium oxide particles. Due to the size and concentration of the particles in the medium, phosphate contaminants are much more likely to bond to them than to the surface of the ceramic restoration. Ivoclean absorbs the phosphate contaminants like a sponge and thus leaves behind a clean zirconium oxide surface. After having rinsed the restoration with water, it has to be conditioned again with the primer. Thus creates the basis for a strong, durable bond between the adhesive luting material and the restoration.

CONCLUSION

In the field of post-core dentistry, PEEK has been recently introduced to be an alternative treatment option for many conventional methods. However, the literature is limited, and further randomized controlled trial studies have to be conducted for PEEK to be the material of choice for custom made post and core systems.

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