Fibreglass-reinforced composite endodontic posts

By Prof. Dr Jürgen Manhart

The prosthetic treatment of seriously damaged, endodontically treated teeth often requires an endodontic post as an additional retention element for buildup with crown restoration. In addition to metal-based posts and zirconia-based ceramic posts, fibre-reinforced composite posts have recently become the center of interest for dentists and science.

In the past it was commonly accepted, to some extent, that teeth would become brittle after root canal treatment, which manifested as an increased risk of fracture. Allegedly, the strengthening effect of endodontic posts should compensate for the weakness. Today, we know that the mechanical properties of tooth substance are not significantly impaired by endodontic treatment [5, 12].

Weakening of endodontically treated teeth is rather the result of additional carious or traumatic destruction, preexisting loss of tooth substance through the endodontic cavity/trepanation access and the preparation of the root canals [6, 13]. Further tooth substance removing measures, such as unnecessary, expansive preparations of the canals and post bed drillings for endodontic posts, additionally weaken the tooth. The strength of endodontically treated teeth cannot be increased through endodontic posts. On the contrary, weakening and/or an increase in clinical failure in teeth with endodontic posts have been established.

Indications for endodontic posts

Reliable mounting for the definitive restoration while preserving the maximum amount of healthy tooth substance possible should be the aim with the coronal buildup of endodontically treated teeth [10]. The use of endodontic posts can be avoided in many cases today with the help of the adhesive technique. In cases with an insufficient amount of coronal tooth substance, a composite buildup for endodontic posts with only adhesive anchoring offers the possibility of creating additional retention for the buildup. The answer to the question of whether an endodontic post is necessary, thus, depends on the degree of destruction of the clinical crown:

Teeth with a minimal amount of destruction can be prepared using adhesive-anchored direct composite buildup for the prosthetic restoration.

With a medium amount of destruction, a buildup with post anchoring can likewise be avoided thanks to the adhesive technique.

With an extensive amount of destruction of the clinical crown, an endodontic post should be used to create reliable anchoring of the buildup.

More exact information on this topic as well as the answer to the question of when is the correct time as to the preparation of the final restoration can be taken from the shared scientific opinion of the DGZMK [German Academic Association of Dentistry], DGZPW [German Association of Prosthodontics and Dental Materials] and the DGZ [German Association of Dentists] in “Aufbau endodontisch behandelter Zähne” [2003] [English translation: Buildup of endodontically treated teeth].

Requirements of endodontic posts

The fundamental requirements of endodontic posts include, among other things, high tensile strength, high fatigue resistance to occlusal and shear loading and stress-free distribution of the forces affecting the tooth root. Excellent fitting accuracy, biocompatibility and electro-chemical innocuity are also essential. Unnecessarily weakening the tooth root through increased substance loss should be avoided by selecting a suitable post form [1].

For therapy of aesthetically challenging situations these days, full-ceramic crowns and bridges fabricated from translucent ceramic are widely used, especially in the anterior and premolar regions. These are comparable to natural teeth with respect to their light conducting properties. The expectations of the optical properties of endodontic posts are rising in response to the demand for aesthetic restorations in teeth that have undergone root canal therapy. Unaesthetic effects, originating from the endodontic post shining through and metal or black carbon fibre posts construction, cannot be reconciled with high expectations of aesthetic results [10].

In addition to metal pins, which can be subdivided into active pins with screw thread and passive designs, up-to-date metal-free systems made from high-strength zirconium oxide ceramic and fiber-reinforced composites are available [1]. The disadvantages of metal posts particularly include, in addition to the unfavourable optical properties, high rigidity [high E modulus] with resulting concomitant risk of arising hypercritical stress peaks [with active posts foremost from the thread outward] and the problem of corrosion. Full ceramic posts made from zirconium oxide are indeed almost tooth-coloured. They
represent, however, an increased risk in the occurrence of tension peaks. This is due to extremely hard and inelastic materials (E modulus ca. 200 GPa) that are not in harmony, from a biomechanical viewpoint, with the relatively elastic dentine (E modulus ca. 18-20 GPa) of the tooth root. A consequential increased risk for root fractures will be discussed. In most cases involving complications, the zirconium oxide posts cannot be removed without considerable and irreparable damage to the tooth root due to their considerable hardness.

**Fibre-reinforced composite endodontic posts**

Fibre-reinforced composite posts consist of a resin matrix, in which structural reinforcing carbon fibres or quartz/glass fibres are embedded. Black carbon fibre-reinforced composite posts are, on the one hand, poorly suited for combination with translucent full ceramic restorations due to their unfavourable optical properties. On the other hand, carbon fibre posts also have unfavourable biomechanical properties (significantly higher E modulus, ca. 120 GPa) in comparison to the nearly tooth-coloured quartz fibre and glass fibre posts.

The quality of fibre-reinforced composite posts, which are now offered by a large number of manufacturers, varies great. The manufacturing process determines the quality. The highest quality provides the most even distribution of the fibre in the organic matrix possible with the packing of the fibres as dense as possible, a good combination of fibres with the matrix, a high degree of polymerisation of the organic components and a homogeneous post structure absent of blisters and inclusions [3]. After polymerisation, the blanks are brought into their final form through a milling process. There are different post geometries, which also exhibit considerable differences in surface quality due to variations in the milling.

Endodontic posts fabricated from quartz fibre- or glass fibre-reinforced composite have favourable biomechanical properties. They feature high tensile strength and, at the same time, exhibit elasticity characteristics that are similar to dentine [11]. This minimises the risk of root fractures, caused by tension peaks induced by loading and shear forces, through the most stress-free distribution possible of these arising forces in the tooth root. The even load distribution is supported through the friction-locked bond between post and tooth substance, due to the adhesive luting of the fibre post in the root canal with composite cement. The adhesive bond, however, appears to be inferior to the radicular dentine due to the structural differences in comparison to coronal dentine sections [4, 8].

The favourable optical properties of tooth-coloured fibre posts (glass- and quartz fibre), which are consistent with natural teeth in their ability to conduct light, facilitate the goal of aesthetic, high quality restorations when they are combined with full ceramic materials. The posts can be processed in one time-saving surgery visit that eliminates the laboratory step, due to the direct technique in combination with an adhesive composite buildup. They also permit a procedure that is gentle to the tooth substance: Thin dentine walls are stabilised by the plastic buildup composite and the composite cement. Moreover, the areas underneath can be saved and maintained as additional retentive areas for the plastic buildup composite restoration [9].

The rare failures of fibre posts are either due to loss of adhesion or caused by a fracture of the post. Catastrophic collapse, which leads to a fracture in the tooth root, is less likely in contrast to posts made from metal or zirconium oxide [7]. Contrary to tooth-coloured posts made from zirconium oxide, posts made from fibre-reinforced composite can be removed from the root canal, if the need arises, without serious problems caused by excavation with a rotating instrument.

**Clinical case**

The following clinical case represents the clinical steps involved in the utilisation of a fibre-reinforced composite endodontic post in a middle maxillary incisor and the subsequent treatment with a full ceramic crown.

A 38 year old patient presented in our surgery with the desire to replace an unsightly crown on tooth 11 and have a veneer placed on tooth 21 [Fig. 1]. The porcelain-fused-to-metal crown on the right middle incisor was much too short and the tooth core was extremely discoloured. The tooth reacted unremarkably to percussion and did not display any irritation to the cryogenic spray in the sensitivity test. An endodontically treated tooth with a metal post in the root and a normal periapical region was identified in the x-ray [Fig. 2].

![Fig. 1: Initial situation: Unsightly crown on tooth 11.](image1)

![Fig. 2: The x-ray shows an endodontically treated tooth with a metal post.](image2)

![Fig. 3: Situation after removal of the PFM crown. Removal of the buildup material.](image3)

![Fig. 4: Loosening the post with ultrasonic energy.](image4)

![Fig. 5: The carefully removed metal post.](image5)

![Fig. 6: Preparation of the post bed with a length-marked standard drill.](image6)
Other than a large, mesial, provisional composite buildup, tooth 21 was clinically and radiologically unremarkable. After presenting and explaining the therapy alternatives, a decision was reached to remove the crown on tooth 11 and attempt to take out the metal post. Subsequent insertion of an adhesively anchored, fibre-reinforced, composite endodontic post and fabrication of a zirconium oxide ceramic crown were planned. A ceramic veneer for tooth 21 was also arranged.

After the crown was removed from tooth 11, the buildup material was carefully removed and the coronal portion of the metal endodontic post displayed (Fig. 3). The post exhibited good retention, so an attempt was made to destroy the integrity of the cement with ultrasonic energy (Fig. 4), in order to remove the post without endangering the root (caveat: longitudinal fracture). After a short time, the post loosened and could be easily removed from the canal (Fig. 5). After displaying the metal post through the enlarged root canal access, the length of the existing depth drilling was determined with an endodontic instrument in order to subsequently follow this path again. This would be carried out from a coronal reference point moving outward with a precision drill from the selected post system.

A glassfibre-reinforced composite post that could be adhesively luted (Rebilda Post, Voco) was chosen as the post system. After placing a retraction cord and selecting the appropriate post diameter, the excavation of the post bed drilling in the root canal was carried out with a depth-marked precision drill (Fig. 6). The penetration depth was already preset by the old metal post in this special case. The length of the post drilling should generally be chosen so that at least 4 mm of root filling remain, in order to tightly seal the apical section of the apex.

Figure 7 shows the try-in of the Rebilda Post (Voco) with the coronal maximum possible diameter (2.0 mm) available. The fibre-reinforced post was inserted into the cavity and parietal fit verified. Rebilda Post glassfibre-reinforced composite posts are available in 3 sizes (coronal diameter: 1.2 mm, 1.5 mm and 2.0 mm) and have a cylindrical-conical design. The tapered anatomical shape of the tooth root is taken into account in the apical region with the conical shape of the post. This permits a preparation that is gentle to the tooth substance, compared to the preparation required for straight, parallel-walled post systems.

Cleaning the post with alcohol, drying it with air and subsequent silanisation (Ceramic Bond, Voco) are carried out by the dental assistant as preparation for the luting. The task of disinfecting the post drilling is performed with an endodontic instrument. The excess cement that escapes from the coronal opening of the post drilling is equally utilised as part of the buildup filling. The coronal composite buildup with Rebilda DC is created in the same way as the application cannula after the post is inserted (Fig. 13). The composite was subsequently polymerised for 40 seconds (Fig. 14) with a polymerisation light. After removing the matrix, tooth 11 was immediately prepared for the accommodation of a zirconium oxide ceramic crown (Fig. 15). A prepared dentinal edge is clearly discernable beneath the composite buildup. The dentine border, which is a minimum of 2 mm wide on all sides in the ideal case, will be circularly...
surrounded by the definitive crown. This so-called Ferrule effect stabilises the tooth root treated with an endodontic post and increases the verifiable solidity of the restored system. The left, middle incisor has been prepared for a ceramic veneer (Fig. 15). A temporary was fabricated from the impressions that were taken (Fig. 16). The adhesively cemented fibre-reinforced composite post is clearly discernible on the verification x-ray (Fig. 17). Figure 18 shows the completed, restored teeth with an integrated zirconium oxide crown on tooth 11 and adhesively luted ceramic veneer on tooth 21.

**Summary**

Endodontic posts do not increase the stability of the remaining tooth substance in endodontically treated teeth. On the contrary, they rather weaken them as a result of the additional substance loss due to the post bed drilling. In many cases with a high degree of damage to the clinical crown, the additional loss of this tooth substance is necessary for the long-term retention of the buildup. A system should thus be chosen that minimizes the risk of root fracture, based on biomimetric properties. Adhesively luted endodontic posts reinforced with glass- or quartz-fibre lead to better homogeneous tension distribution when loaded than metal or zirconium oxide ceramic posts and contemporaneously possess advantageous optical properties. To date, however, there are only relatively few clinical studies on metal-free post systems that are promising. There are admittedly substantial differences in the mechanical loading capacity of the different fibre-reinforced endodontic posts. The practitioner should be aware of such differences in order to select a suitable post system followed by a thorough investigation.

**Literature**


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**Fig. 13:** Luting the post and creating the buildup with a low viscosity, dual-curing buildup composite.

**Fig. 14:** Light-curing for 40 s.

**Fig. 15:** Completed preparation for a zirconium oxide crown on tooth 11 and a ceramic veneer on tooth 21.

**Fig. 16:** Provisional treatment.

**Fig. 17:** Verification x-ray.

**Fig. 18:** Completely restored middle maxillary incisor.