Post and core systems: past to present

Douglas Terry and **Edward Swift** demonstrate the utilisation of a fibre-reinforced composite post and core system to restore a fractured endodontically treated maxillary right central

For over two and a half centuries, clinicians have written about the placement of posts in the roots of teeth to retain restorations (Smith, Schuman, Wasson, 1998). As early as 1728, Pierre Fauchard described the use of 'tenons', which were metal posts screwed into the roots of teeth to retain bridges (Smith, Schuman, Wasson, 1998). In the mid-1800s, wood replaced metal as the post material, and the 'pivot crown', a wooden post fitted to an artificial crown and to the canal of the root, was popular among dentists (Smith, Schuman, Wasson, 1998). Often, these wooden posts would absorb fluids and expand, frequently causing root fractures (Smith, Shuman, 1998).

In the late nineteenth century, the 'Richmond crown', a single-piece post-retained crown with a porcelain facing, was engineered to function as a bridge retainer (Smith, Shuman, 1998). During the 1930s, the custom cast post and core was developed to replace the one-piece post crowns. This procedure required casting a post and core as a separate component from the crown (Smith, Shuman, 1998). This two-step technique improved marginal adaptation and allowed for a variation in the path of insertion of the crown (Smith, Schuman, Wasson, 1998).

The failure of post-retained crowns has been documented in several clinical studies (Figures 1a and 1b) (Roberts, 1970). Many of these studies indicate that the failure rate of restorations on pulpless teeth with post and cores is higher than that for restorations of vital teeth (Roberts, 1970).

Several main causes of failure of post-retained restorations have been identified, including:

- Recurrent caries
- Endodontic failure
- Periodontal disease
- Post dislodgement
- Cement failure
- Post-core separation
- Crown-core separation
- Loss of post retention
- Core fracture
- Loss of crown retention
- Post distortion
- Post fracture
- Tooth fracture
- Root fracture (Asmussen, Peutzfeldt, Heitmann, 1999; Zuckerman, 1996; Sirimai, Riis, Morgano, 1999).

Also, corrosion of metallic posts has been proposed as a cause of root fracture (Purton, Payne, 1996).

Today, the clinician can choose from a variety of post and core systems for different endodontic and restorative requirements. These systems and methods are well documented in the literature (Hudis, Goldstein, 1986; Rosenstiel, Land, Fujimoto, 1988; Ziebert, 1989). However, no single system provides the perfect restorative solution for every clinical circumstance, and each situation requires an individual evaluation.

Custom cast post and cores

The traditional custom cast dowel core provides a better geometric adaptation to excessively flared or elliptical canals and almost always requires minimum tooth structure removal (Smith, Schuman, Wasson, 1998).

Custom cast post and cores adapt well to canals with extremely tapered canals or those with a non-circular cross section and/or irregularly shape, and roots with minimal remaining coronal tooth structure (Rosenstiel, Land, Fujimoto, 1988). Patterns for custom cast posts can be formed either directly in the mouth or indirectly in the laboratory. Regardless, this method requires two appointment visits and a laboratory fee. Also, because it is cast in an alloy with a modulus of elasticity that can be as high as 10 times greater than natural dentine (Freedman 1996), this possible incompatibility can create stress

Aims and objectives

To review the various post and core materials and techniques available to the clinician today.

Expected outcomes

Correctly answering the questions on page xx will demonstrate you understand that there are many post and core materials and techniques that are available to the clinician for a variety of clinical procedures and thus each clinical situation should be evaluated on an individual basis.

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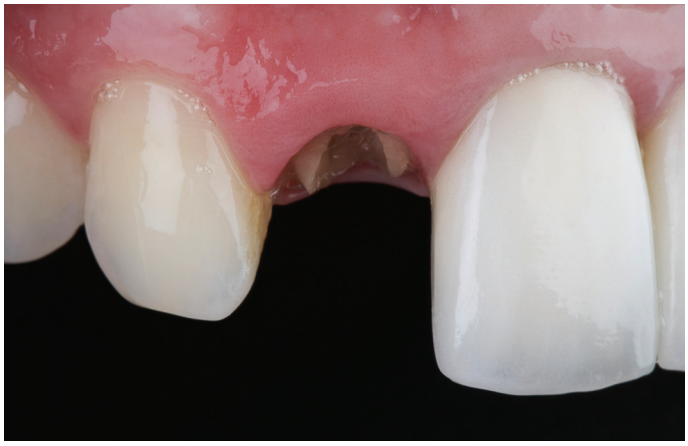


Figures 1a and 1b: Restorative failure of an all-ceramic crown on the maxillary right central occurring after endodontic treatment. A minimum of 1mm dimension is required for a ferrule design

Figures 2a and 2b: After determining the desired post channel length (1/2 to 2/3 length of canal), the gutta percha was removed with a series of pre-shaping instruments (Gates Glidden, SybronEndo; Rebilda post reamer, Voco)

Figure 3: The channel preparation for a prefabricated fibre-reinforced post was performed using a colour-coded drill (Rebilda post drill, Voco) establishing the desired intra-radicular length and size for the selected post

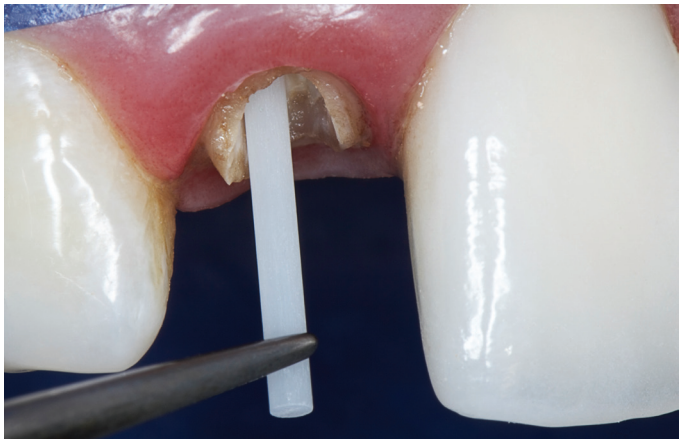


Figure 4: The pre-selected fibre-reinforced composite post (Rebilda post, Voco) was placed into the channel space and the coronal height was measured and marked with a diamond disc to the desired length. The post is cleaned with alcohol and the surface is silanated (Ceramic Primer, Voco) and air dried after 60 seconds

Figures 5a and 5b: A dual-curing self-etch adhesive (Futurabond DC, Voco) was applied with an applicator (Endo Tim, Voco) to the base of the post space, air dried and any excess adhesive was absorbed with an endodontic paper point using a rapid intermittent movement

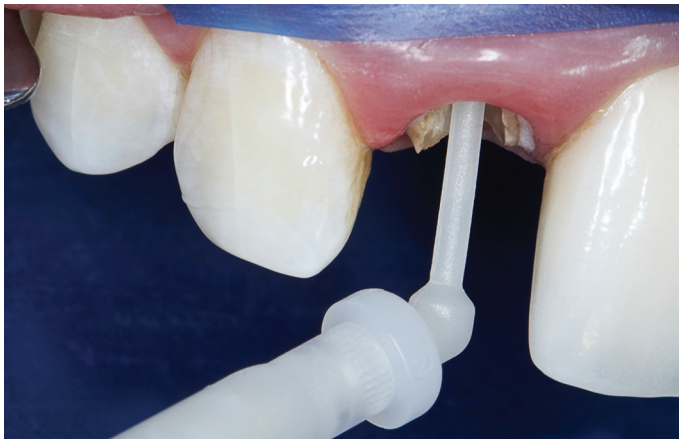
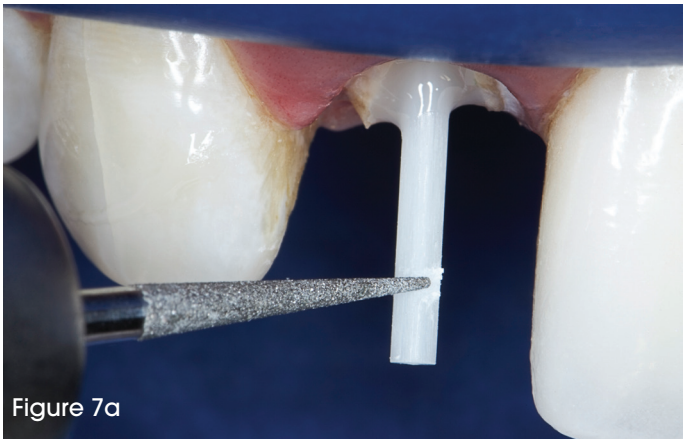
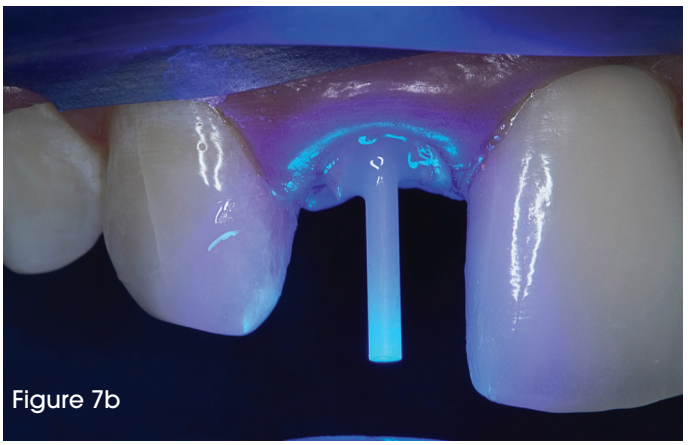


Figure 6: A dual cure resin cement (Bifix QM, Voco) was injected into the post channel using an angled tip (intra-oral tip type 1, Voco). It is important to remove the tip slowly while injecting to prevent air bubbles





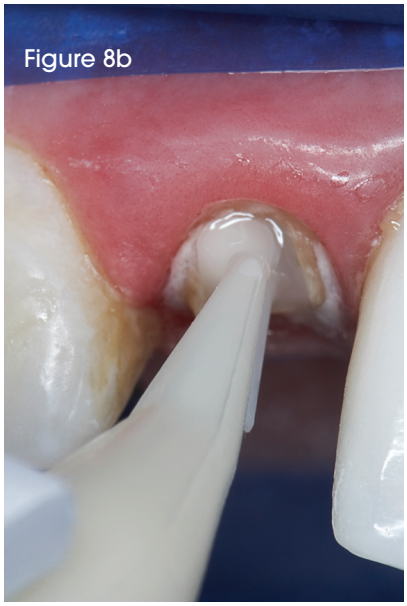
Figures 7a and 7b: The fibre post was immediately inserted into the post hole to the base of the prepared channel (a) and light cured from different positions (i.e., coronal, facial, and lingual) for two minutes (b)

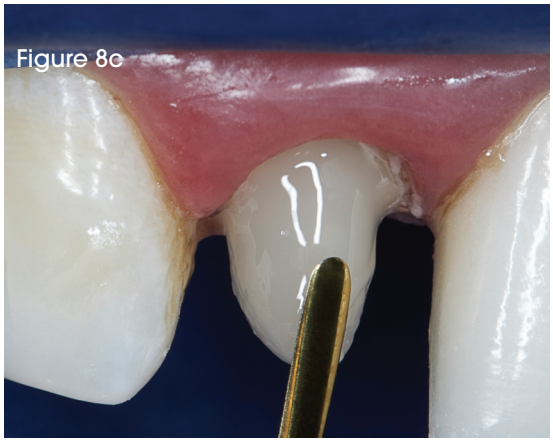
concentrations in the less rigid root, resulting in post separation or failure.

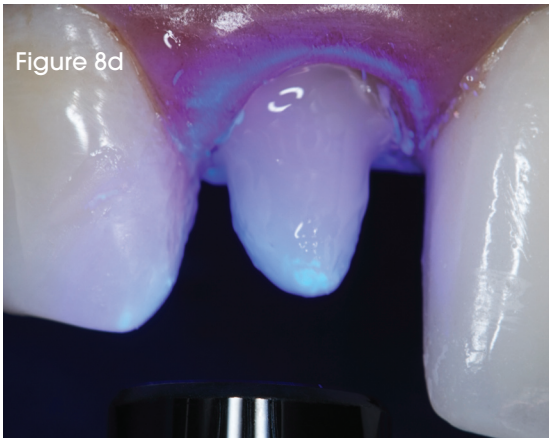
Additionally, the transmission of occlusal forces through the metal core can focus stresses at specific regions of the root, causing root fracture (Freedman, 1996). Furthermore, upon aesthetic consideration, the cast metallic post can result in discolouration and shadowing of the gingiva and the cervical aspect of the tooth.

Prefabricated post and core

An alternative consideration is the prefabricated post and core system. Prefabricated post and core systems are classified according to their geometry (shape and configuration) and method of retention. The methods of retention are designated as active or passive. Active posts engage the dentinal walls of the preparation on insertion, whereas passive posts do not engage the dentine but rely on cement for retention (Smith, Schuman, Wasson, 1998). The basic post shapes and surface configuration are tapered, serrated; tapered, smooth-sided; tapered, threaded; parallel, serrated; parallel, smooth-sided; and parallel, threaded. While active or threaded posts are more retentive than the passive posts, the active posts create high stress during







Figures 8a, 8b, 8c, 8d: A dual-curing self-etch adhesive (Futurabond DC, Voco) was applied to the remaining dentine surface and light cured for 10 seconds. (a) A dual-cure, radiopaque flowable core build-up composite material (Rebilda DC, Voco) was injected over the coronal aspect of the post (b), sculpted with a long bladed interproximal instrument (c) and smoothed with a #2 sable brush to an ideal coronal preparation geometric shape and dimension light cured for 40 seconds (d)

Figure 9: Completed fibre-reinforced composite post and core. The placement of a 1mm circumferential ferrule on sound tooth structure ensures the mechanical retention and resistance

Figure 10: An optimal adhesive integration between the components of the post-retained system that provides a structural integrity for intraradicular rehabilitation

placement and increase the susceptibility of root fracture when occlusal forces are applied. Parallel-sided serrated posts are the most retentive of the passive prefabricated posts and the tapered smooth-sided posts are the least retentive of all designs (Smith, Shuman, 1998).

Traditional prefabricated metal posts are made of platinum-gold-palladium, brass, nickel-chromium (stainless steel), pure titanium, titanium alloys, and chromium alloys (Smith, Shuman, 1998; Asmussen, Peutzfeldt, Heitmann, 1999). Although stainless steel is stronger, the potential for adverse tissue responses to the nickel has motivated the use of titanium alloy (Christensen, 1998). Also, contributing factors to root fracture such as excessive stiffness (modulus of elasticity) (Assif, Bitenski, Pilo, Oren, 1993) and post corrosion (Smith, Shuman, 1998) from many of these metal posts have stimulated concerns about their use.

The non-metallic prefabricated posts have been developed as alternatives, including ceramic (white zirconium oxide) and fibre-reinforced resin posts. Zirconium oxide posts have a high flexural strength, are biocompatible, and are corrosion resistant. However, this material is difficult to cut intra-orally with a diamond, and to remove from the canal for re-treatment (Asmussen, Peutzfeldt, Heitmann, 1999).

The fibre-reinforced composite resin post and core system offers several advantages:

- A one appointment technique
- No laboratory fees
- No corrosion
- Negligible root fracture
- No designated orifice size
- Increased retention resulting from surface irregularities
- Conserved tooth structure
- No negative effect on aesthetics.

The ferrule effect

The successful rehabilitation of any endodontically treated tooth using the post-retained system requires the consideration of one specific structural design characteristic – the ferrule effect. The stability of the crown is influenced by the preparation design for endodontically treated teeth. Preserving tooth structure during preparation is paramount in preventing stress concentrations at the cementoenamel junction of the endodontically restored tooth and provides resistance to tooth fracture.

The completed crown preparation should have a ferrule design that encapsulates the endodontically restored tooth complex. This collar effect provides an anti-rotational feature for the stability of the crown. Clinical studies have demonstrated and confirmed the importance of this coronal tooth 'collar' on the mechanical resistance and retention form of the endodontically restored tooth complex (Terry, Leinfelder, Geller, 2008). The general guideline is a 1-2mm preparation on sound tooth structure. Procedures that provide a shoulder on tooth structure and an axial preparation on the core build-up will have an insufficient ferrule design. In cases where there is insufficient sound tooth structure for this ferrule design, it is necessary to obtain this dimension through periodontal crown lengthening and/or forced tooth eruption procedures.

Currently, an increased demand for clinically convenient post and core systems to replace lost tooth structure has provided the clinician with a plethora of simplified 'one-visit' post and core restorative options. However, in view of the previous considerations, it is understandable that clinicians have uncertainties about selection of restorative materials and techniques to achieve optimal results for post and core build-up procedures.

Conclusion

Although the quest for the ideal material to restore lost tooth structure continues to be a focus of modern dental research, the aforementioned review indicates there are many post and core materials and techniques that are available to the clinician for a variety of clinical procedures and thus each clinical situation should be evaluated on an individual basis (Smith, Schuman, Wasson, 1998).

According to studies by Clinical Research Associates, the fibre-reinforced systems are superior to metal prefabricated posts. In the last few years, there has been a major shift away from metal custom cast post and cores toward resin-based composite cores (CRA Newsletter, 2004). Prefabricated composite post systems are replacing metal post systems because an adhesive procedure with the fibre-reinforced composite post system adds strength to the tooth-restorative interface after bonding. Therefore, the fibre-reinforced post has an advantage after assembly. The fibre-reinforced composite post system has a similar modulus of elasticity to the dentine after bonding, whereas the metal post assembly has an appreciably higher modulus of elasticity. The following illustration demonstrates the utilisation of a fibre-reinforced composite post and core system to restore a fractured endodontically treated maxillary right central. PD

References

For the full list of references to accompany this article please email the editor at siobhan.lewney@fmc.co.uk.

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As part of the International Foundation for Oral Design's 2011 Symposium in London, Douglas Terry will be presenting a one-day course entitled 'Achieving aesthetic and restorative excellence with composite restorations' on 8 May 2011. For more information, please visit www.oraldesignsymposium.com.

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