

Restoration of endodontically treated teeth: The seven keys to success

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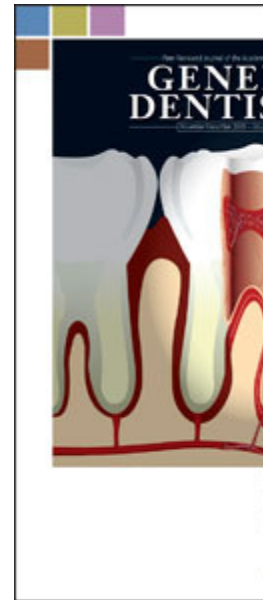
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Preservation of tooth integrity and strength is important for the long-term survival of endodontically treated teeth. post space preparation requires reduction of the remaining supportive tooth structure. Restorative modalities folk must provide sufficient strength for the prosthetic material and tooth structures. This article presents seven key fa into consideration to ensure clinical success when restoring an endodontically treated tooth.

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Several factors play a role in the long-term survival of endodontically treated teeth and associated restorations. T key factors that affect tooth and restoration survival.

Fiber-reinforced resin posts should be used with caution until more long-term data are available

For many years, the standard method for restoring endodontically treated teeth has involved either a custom cas prefabricated metal post with a restorative material core.¹⁻³ A nationwide survey of dentists in 1994 reported that used prefabricated posts, the most popular being the parallel-sided serrated metal post.⁴ It is likely that prefabric increased substantially since that 1994 survey.

The high demand for esthetic restorations and all-ceramic crowns has led to the development of a variety of nonr systems as alternatives to metal posts.⁵⁻⁸ In addition to the esthetic advantages of nonmetallic posts, laboratory : these posts offer favorable physical and mechanical properties and less root fracture compared to metal posts.⁹⁻ fiber-reinforced posts have produced a wide range of reported failure percentages, ranging from 0% (after a mea 11.4% (after two years).¹⁴⁻²³ The most commonly reported complications are post loosening and root fracture (Fi core and the final restoration both depend on the retentive capacity of the post.²⁷

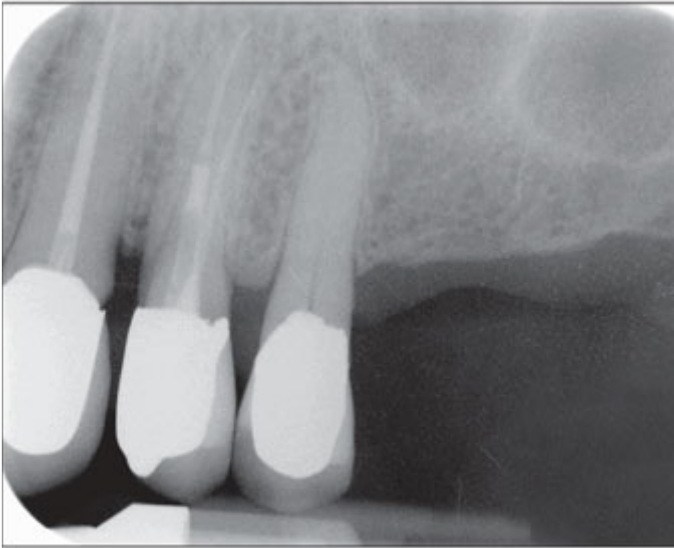


Fig. 1. A radiograph of a fractured maxillary first premolar with a prefabricated non-metallic post.



Fig. 2. A maxillary left central incisor with a broken core retained by a non-metallic prefabricated post.

Given the wide range of reported failure percentages, it appears that more long-term clinical data are needed to evaluate the use of fiber-reinforced posts.

Crowns should be placed on most endodontically treated posterior teeth to enhance their longevity

Clinicians have observed a difference between endodontically treated teeth and vital teeth. Endodontically treated teeth have a higher failure rate than vital teeth. They tend to break during extraction; in addition, pulpless molars without crowns can fracture.^{28,4}

Multiple studies have shown that endodontically treated teeth benefit from the placement of crowns. Aquilino and colleagues reported that endodontically treated teeth with crowns had a survival rate six times greater than that of teeth without crowns (Fitzgerald evaluated 116 teeth that had failed and were extracted; the authors reported that endodontically treated teeth without crowns were lost after an average of 50 months, while endodontically treated teeth with crowns were lost after an average of 87 months).



Fig. 3. *Left:* An occlusal view of a fractured endodontically treated mandibular right first molar. *Right:* The extracted tooth reveals

According to several clinical studies, fixed partial dentures have increased clinical failure when they are supported by abutment teeth rather than vital abutment teeth.^{28,32-35} One study determined that crowns significantly improved the success of treated posterior teeth but did not improve the success of anterior teeth, indicating that intact endodontically treated posterior teeth require complete crown coverage unless they are weakened by large and/or multiple coronal restorations or they require a crown for color or form.³⁶

Conversely, Mannocci et al evaluated endodontically treated premolars that had been restored (both with and without posts) with either a post or direct composite resin restorations and reported similar success rates for both.³⁷ A similar retrospective study by Nagasiri and Chitmongkolsuk indicated that endodontically treated molars that are intact (except for the access opening) can be successfully restored using composite resin restorations.³⁸

After considering the available data, the authors recognize the potential benefits of using composite resin to restore intact teeth except for the access opening. However, since wear is an indicator of the forces that will be brought to bear on the tooth, more data are needed to determine the long-term success of these teeth when varying degrees of occlusal wear are present. The authors recommend using crowns that encompass the cusps because they will help cusps that have been weakened by structure removal to withstand the occlusal forces of everyday mastication.

Conversely, it may be possible to avoid placing crowns on some previously restored posterior teeth, such as mandibular molars with small, poorly developed lingual cusps that would not be subjected to the wedging effect from opposing cusps. While there is little chance that occlusal forces will separate the cusps, so the access opening can be restored without a full coverage crown.³⁹

Posts weaken endodontically treated teeth rather than enhance their clinical longevity

Historically, the use of posts has been based on the concept that they reinforce teeth; however, nearly every lab study has shown that posts either fail to increase the fracture resistance of extracted endodontically treated teeth or that they decrease the fracture resistance of the tooth when force is applied via a mechanical testing machine.⁴⁰⁻⁵⁰ Pontius and Hutter reported that maxillary premolars resisted higher failure loads than those with posts and crowns.⁴² Gluskin et al found that mandibular incisors with posts and cores exhibited greater resistance to transverse loads than teeth with posts and cores.⁴³ These studies showed no evidence that posts reinforce teeth (Fig. 4).



Fig. 4. A radiograph of a fractured maxillary second premolar with a prefabricated metallic post.

Clinical studies also have failed to provide definitive support for the concept that posts strengthen endodontically treated teeth. In a longitudinal radiographic study, Eckerbom et al evaluated the radiographs of 200 consecutively treated patients before and after endodontic treatment and reported that teeth with posts had significantly more apical periodontitis.²⁹ In a 2003 clinical study, Goodacre et al noted fractures in 3% of teeth with posts, with no evidence that posts enhanced fracture resistance. They have had little effect on the clinical success of fixed partial denture abutments but they have been reported to improve the success of removable partial denture abutments compared to endodontically treated abutments that did not use posts.³⁶

Clinical and laboratory data indicate that teeth are not strengthened by posts; rather, their purpose is to retain a core or provide adequate support for the definitive crown or prosthesis. Unfortunately, this primary purpose has not been completely achieved. A survey showed that 24% of general dentists felt that posts strengthen teeth.⁵³ A year earlier, Morgano et al reported that 50% of general dentists believed that a post reinforces the tooth, compared to only 41% of dentists under age 41.⁴ Thirty-nine percent of full-time faculty, and 56% of non-faculty practitioners felt that posts reinforce teeth.⁴ In a survey conducted in 1998, it was found that 29% of general dental practitioners felt that a post reinforced the tooth, compared to 17% of board-certified dentists.

Since posts do not appear to reinforce teeth, they should be used only when the core cannot be retained by any other means.

To ensure an adequate apical seal, 5 mm of gutta-percha should be retained

After an endodontically treated tooth is prepared for a post, the remaining gutta-percha at the apex is the only barrier to leakage into the periapical area. Several studies showed that leakage increased when only 2–3 mm of gutta-percha was retained. A length of 4–5 mm of gutta-percha ensures an adequate seal.⁵⁴⁻⁶⁰ Although multiple studies indicate that 4 mm produces an adequate seal, a precisely 4 mm length is difficult and radiographic variations in angulation could lead to retention of less than 4 mm. It is recommended to be a safer minimal radiographic length.

The best method for preserving the apical seal during preparation of a post space is to use the working length determination instrument; the same reference point used on the tooth during endodontic therapy should be used during post preparation. An instrument with an appropriate diameter should be used with a rubber stopper placed around the instrument to help ensure that an adequate amount of gutta-percha is retained apically.

Three methods have been advocated for removing gutta-percha when preparing a post space without disturbing the apical seal: thermal, and mechanical.^{54,57,61-64} According to the literature, both hot hand instruments and rotary instruments adequately condensed gutta-percha, provided 5 mm is retained apically.^{54,57,62-64} Several studies have determined that removal of gutta-percha immediately after root canal treatment has no detrimental effect on the apical seal.^{55,56,58,61,65}

Short posts should be avoided

The appropriate length for a post should minimize the potential for damage to the tooth, optimize post retention, and provide an adequate apical seal for the root canal restoration. Several guidelines for determining the length have been proposed.^{2,66-68}

While short posts have never been advocated, they have been observed frequently on radiographs (Fig. 5). A 1998 study by McAndrew examined 327 posts and found that only 111 (34%) were as long as the incisocervical length of the crown.

endodontically treated teeth, Ross determined that only 28 posts (14%) were equal to or greater than 66% of the radiographic study of 217 posts determined that 11 (5%) were 66–75% of the root length.⁷² Root fractures cause more frequently when short posts are used.^{49,73-76} According to Trabert et al, increasing the length of a post increases the risk of root fracture.⁷⁷



Fig. 5. A very short post in the root of a maxillary right lateral incisor that will result in loosening and failure of the prosthesis.

Leary et al determined that posts that are equal to 75% of the root length offered the greatest rigidity and product. However, it can be difficult to utilize this apparently optimal post length. When a tooth has an average or below a post occupies two-thirds or more of the root length, it is not possible to retain 5 mm of gutta-percha at the apex.⁷⁴ Post length is determined by retaining 5 mm of apical gutta-percha and extending the post to that depth.

This post length guideline is appropriate for all teeth except for molars. Abou-Rass et al examined 150 extracted molars and determined that molar post spaces should not be prepared more than 7 mm apical to the orifice of the roots (the distal root of mandibular molars and the palatal root of maxillary molars) because of the increased potential for root fracture. Secondary roots (that is, the facial roots of maxillary molars and mesial roots of mandibular molars) cannot accommodate posts without excess root thinning and potential perforation.

The potential for root thinning, perforation, and root fracture increases with large-diameter posts

Increasing the diameter of a post weakens the remaining root. It has been determined that stresses in a root increase with post diameter.⁸⁰ Larger post diameters decrease the resistance to tooth fracture.⁷⁷ Deutsch et al determined that using posts with diameters 1 mm or more increased the potential for root fracture sixfold for every millimeter of decreased root diameter.⁸¹

According to the literature, root fracture is the second most common cause of post and core failure.^{14,16-18,25} Multiple studies have been associated with the potential for root fracture: large-diameter posts, short posts, and threaded posts (Fig. 6);⁷⁸ it is recommended that post diameter should not exceed one-third of the root diameter and that post diameters be proportional to average root dimensions.⁷⁹

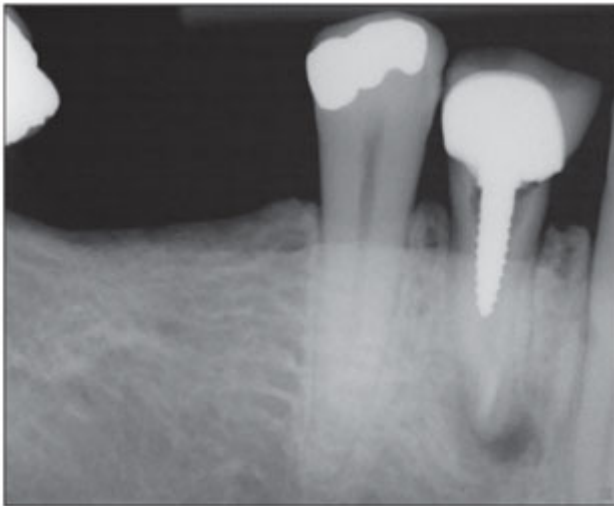


Fig. 6. A threaded post in a mandibular first premolar that has caused root fracture.

The post should be between 0.6–1.2 mm in diameter, depending on the tooth being restored.⁸⁴⁻⁸⁶ Only post prep match the desired diameter of the post space should be used. When using a particular brand of post, make sure are made by the same manufacturer.

Understanding dental anatomy, the configuration of the roots and their variations, and appropriate instrument ang avoid root thinning and perforation. Instruments should be angled so that they follow the canal. Figure 7 is an ex: was perforated because the instruments were at an improper angle when preparing the post space.

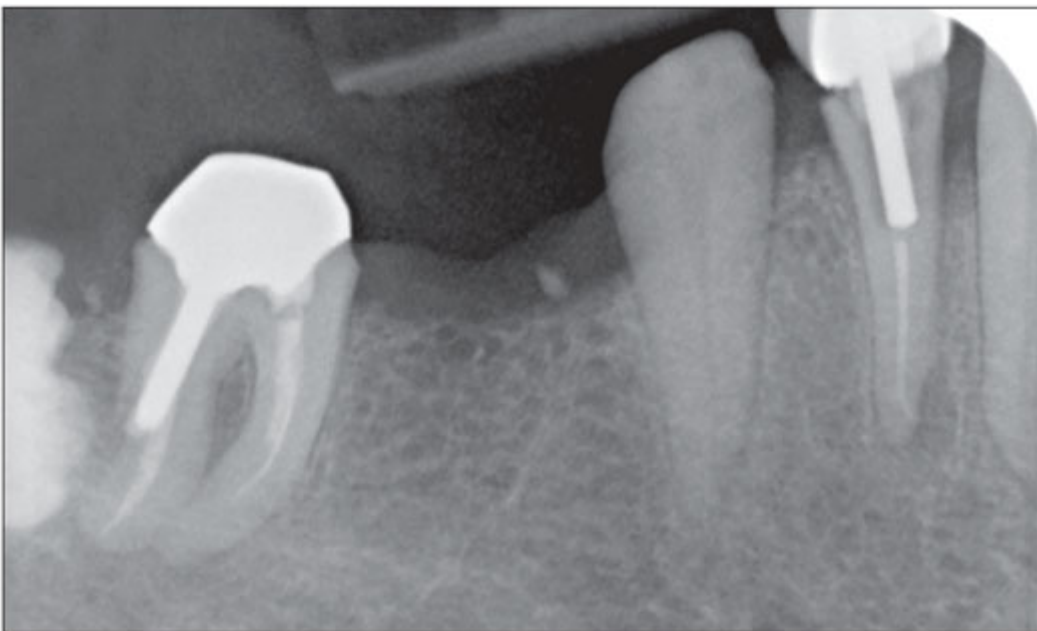


Fig. 7. A perforation in the distal root of the mandibular right second molar, the result of a post space prepared with instruments that were not held parallel to the root canal.

When posts are needed in premolars, it is best to place them in the palatal root of the maxillary premolar and in t mandibular premolar with multiple roots. Root taper, curvature, and depressions should be reviewed prior to post

When posts are needed in molars, they should be placed in roots with the greatest dentin thickness. These roots

maxillary molars and the distal roots of mandibular molars) are known as the primary roots. However, it is important to avoid extending a post more than 7 mm apical to the root canal orifice in primary canals. In mandibular molars and the facial roots of maxillary molars should be avoided, if possible. Dentists also should avoid pressure on the root surface toward the furcation, as this surface is thinner than the outer surface due to root curvature.

For all teeth, the apical 5 mm of the roots should be avoided because most root curvatures occur within 5 mm of the apex. Extending into this area increases the risk of excessive root thinning or perforation.

A cervical ferrule should engage tooth structure to prevent root fracture

Ferrules can be established by the core engaging tooth structure (known as the core ferrule) or by the overlying crown structure (known as the crown ferrule).⁸⁸⁻⁹⁷ The data indicate that crown ferrules are more effective than core ferrules for the tooth's resistance to fracture.^{89,91-93,98} Although the data indicate the benefit of a crown ferrule, not all practitioners agree. According to a survey by Morgano et al, 56% of general dentists, 67% of prosthodontists, and 73% of board-certified dentists reported that core ferrules increased a tooth's fracture resistance.⁴

Different lengths and forms of the ferrule have been studied in the literature.^{92,94,95,99} The length and form are essential for a ferrule effect. When possible, encompassing 2.0 mm of intact tooth structure around the entire circumference of the crown is an effective crown ferrule. Ferrule effectiveness is enhanced by grasping larger amounts of tooth structure. The amount of tooth structure engaged by the overlying crown appears to be more important than the length of the post in increasing a tooth's fracture resistance.⁸ Figure 8 presents a case in which the length of the post was appropriate; however, the lack of a ferrule caused the restorations to fail.



Fig. 8. *Left:* A clinical photo of a patient with very little cervical tooth structure for crown retention. *Right:* A crown with a fracture line on the labial surface several months after placement.

If cervical tooth structure is insufficient for developing a ferrule, surgical crown lengthening or orthodontic extrusion may be used to expose more tooth structure. It may be prudent to extract a tooth and replace it with an implant and crown when crown lengthening would create an unacceptable esthetic environment or produce a furcation defect. If a furcation defect is present that would not allow for the development of appropriate post length.

Summary

Due to the wide range of reported failure rates in available clinical studies, fiber-reinforced resin posts should be used only when the core cannot be adequately retained by any other means. Long-term clinical data become available. Crowns are not needed for intact or minimally restored anterior teeth unless orthodontic extrusion changes cannot be accomplished by more conservative means. Crowns should be placed on most endodontically treated teeth to enhance their long-term survival. Some data indicate that posterior teeth that are intact except for the access opening can be restored satisfactorily with composite resin rather than a crown; however, the long-term success of this more conservative approach under heavy occlusal forces is unknown.

Posts weaken teeth and should be used only when the core cannot be adequately retained by any other means. Posts should be retained by preserving 5 mm of gutta-percha. Short posts should be avoided, as they increase the potential for root fracture. Except for molars, optimal post length is determined by retaining 5 mm of apical gutta-percha and extending the post to the root canal orifice.

posts should be placed only in the primary roots (palatal roots of maxillary molars and distal roots of mandibular molars) and should not extend more than 7 mm apical to the orifice of the root canal due to the potential for root thinning or perforation.

To minimize root thinning and the potential for root fracture, the diameter of posts should not exceed one-third of preparation instrument diameter should be matched to root diameter. Since crown ferrules increase the resistance to fracture, ferrules placed on endodontically treated teeth should encompass 2.0 mm of tooth structure apical to the core whenever possible.

Author information

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