International Journal of Biomedicine 15(3) (2025) 446-451
http://dx.doi.org/10.21103/Article15(3)_RA2

REVIEW ARTICLE

INTERNATIONAL JOURNAL OF BIOMEDICINE

Post-Endodontic Restorative Treatment, Types of Post-and-Core Systems: A Narrative Review

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Abstract

Coronal restorations after endodontic treatment are fundamental to achieving long-term results. There are a variety of post types used in post-endodontic restoration to improve clinical outcomes, ensuring the stability and retention of crown restorations and their resistance against fracture. This narrative review explains the restorative phase after endodontic treatment, focusing on the large variety of posts and cores, with an emphasis on tooth preservation. Metal posts and cores have been widely used, but current posts that have gained interest due to their flexibility, elasticity, and aesthetic aspect are fiber and ceramic posts. Factors such as tooth structure remaining, tooth location, and proper obturation, as well as post space, length, diameter, and ferrule design, may affect the choice of posts that will be applied after endodontic treatment..(**International Journal of Biomedicine. 2025;15(3):446-451.**)

Keywords: post-endodontic restoration • post • core • root fracture

For citation: Kuçi L, Muçaj E, Muçaj E, Muqolli G. Post-Endodontic Restorative Treatment, Types of Post-and-Core Systems: A Narrative Review. International Journal of Biomedicine. 2025;15(3):446-451. doi:10.21103/Article15(3)_RA2

Introduction

Devitalized teeth that have undergone endodontic treatment and lost their natural vitality are prone to cracking and fractures over time due to masticatory forces.[1] These teeth are vulnerable because of the volumetric loss of hard tissue and the endodontic treatment itself.[2] Therefore, restoring the structural integrity of the crowns of these teeth is crucial to prevent fractures and maintain oral function.[3] Tooth loss due to fractures often necessitates complex and costly treatment procedures. Consequently, post-endodontic restoration of the crown should prioritize preserving as much healthy tooth tissue as possible.[4] Moreover, in cases where the marginal ridge is not intact, cuspal coverage is recommended to improve fracture resistance against occlusal forces.[5] The dehydration of devitalized teeth causes dentin brittleness, reducing their ability to absorb masticatory forces and inhibiting uniform force distribution.[6] The reduced flexibility of these teeth makes them less capable of withstanding masticatory forces.[7] Additionally, the loss of tooth structure compromises its mechanical strength. Over time, constant masticatory forces on endodontically treated teeth may lead to craze lines, cracks, and vertical root fractures.[8,9]

According to studies, fractures most commonly occur in the crowns of posterior teeth that have undergone endodontic treatment.[10] Meanwhile, narrower roots are more prone to fractures.[11] As a result, when there is not sufficient tooth structure remaining to support the crown restoration, a post and a core are needed.

The post is a biocompatible material that is inserted into the root canal (Figure 1), and the core is built over the post to replace missing tooth structure. Teeth with inadequately placed posts or subjected to excessive forces are also susceptible to vertical root fractures.[12]

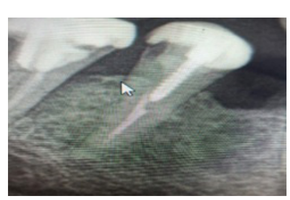

Figure 1. *Metal post in root canal.*

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This article aims to review the relationship between endodontically treated teeth and restorative procedures. By synthesizing and critically assessing the available literature, this study seeks to provide a comprehensive analysis of the efficacy, advantages, and limitations of endodontically treated teeth in preventing root fractures.

Materials and Methods

An extensive literature review was conducted using databases such as PubMed, Scopus, and Google Scholar. Keywords included “endodontic treatment,” “post,” “core,” and “root fractures.”

The inclusion criteria included studies published within the last 20 years, peer-reviewed articles, and both clinical and laboratory studies. Studies were selected based on their relevance to the impact of root canal treatment on tooth integrity, particularly regarding the post-placement period. Exclusion criteria included articles focused solely on other dental treatments, non-English publications, and studies without direct implications for tooth structure.

Relevant data, including study design, sample size, treatment methods, and outcomes, were extracted for analysis. Emphasis was placed on the relationship between endodontic procedures and post placement.

The Role and Function of Dental Posts

In restorative dentistry, posts are used to provide retention and stability for crown restorations in endodontically treated teeth. Posts serve as an anchor for the core material and crown, collectively restoring function and reinforcing the tooth.[13] The post acts as a support structure for the base material, which fills the void within the root canal of the treated tooth, as well as for the crown.

A conservative endodontic approach reduces tooth resistance by approximately 5%, while a mesio-occlusal-distal preparation can reduce resistance by about 63%. Finite element analysis studies by Sathorn et al.[14] demonstrated that increased root canal diameter and reduced dentin wall thickness lead to stress concentration. Thus, the mechanical strength of an endodontically treated tooth correlates with the amount of remaining tissue.[15]

Maintaining a 2-mm margin of healthy dentin provides the ferrule effect, which protects the root against gingival margin fractures.[16,17] An appropriate ferrule effect reduces stress concentration within the tooth structure, minimizing stress on the post and adhesive interfaces.[18]

Another biomechanical factor is the root canal anatomy. Versluis et al.[19] found that maxillary central incisors with circular canals evenly distribute stress, making them less prone to fractures than oval canals, which concentrate stress on the buccal and lingual surfaces of the root.

Today, there are many materials for posts and cores, including prefabricated and custom-made options. Factors such as elastic modulus, diameter, and height influence the fracture resistance of restored teeth.[20]

Types of Dental Posts

Metal posts

Metal posts are made from stainless steel, titanium, gold alloys, and other metals. Historically, these posts have been the most used, particularly stainless steel posts, due to their ease of application, cost-effectiveness, efficiency, and ability to provide retention and stability.[21] Metal posts are strong and durable against occlusal forces and bruxism in posterior teeth. Their rigid and smooth structure aids in anchoring the base material within the root canal,[22] creating a strong mechanical bond between the restorative material and surrounding dentin. Their corrosion resistance prevents allergic reactions or other complications.[23] However, the drawbacks of metal posts include differences in elasticity between the post and the tooth structure, which can lead to fractures.[24] Additionally, the metallic color can create aesthetic mismatches with the tooth structure, affecting the natural appearance. Light reflection from the metal post can also result in an unnatural look. Another disadvantage is the potential compromise of tooth tissue due to the destructive preparation needed for the post's application.[21]

Fiber Posts

Modern restorative dentistry employs adhesive composites to build the core and form a mechanical unit with the tooth. Several types of post-core systems are worth highlighting.

Carbon fiber-reinforced posts are embedded uniformly in the epoxy resin matrix, with carbon fibers produced by heating polyacrylonitrile in air at 200–250°C, and in an inert atmosphere at 1200°C.[7] Carbon fiber-reinforced posts demonstrate higher fatigue strength, tensile strength, and elasticity comparable to dentin.[26] However, their black color may reflect through aesthetic restorations, and their minimal radiopacity makes them less favorable.[7]

According to King et al.,[25] carbon fiber-reinforced posts show better fracture resistance and elasticity than prefabricated metal posts. However, teeth restored with carbon fiber-reinforced posts exhibited lower fracture resistance compared to cast post-and-core restorations.[26]

In cases where the ferrule is minimal or absent in an endodontically treated tooth restored with a carbon fiber-reinforced post, the post may flex under load, causing micromovement of the core. This can compromise the cement seal at the crown margins, leading to microleakage of oral bacteria and fluids. As a result, secondary caries may develop, which may go undetected.[7]

The glass fiber-reinforced epoxy resin posts are made of glass or silica fibers (quartz), making them translucent or white, thereby providing a favorable aesthetic appearance. These posts are silica-based (50–70% SiO_2), along with other oxides.[27]

Studies have found that posts with higher glass fiber content displayed greater strength. Glass fiber-reinforced posts have been reported to exhibit high fatigue strength, high tensile strength, and a modulus of elasticity closer to dentin than carbon fiber-reinforced posts.[28] Galhano et al.[29] reported that regarding flexural strength, all the posts behaved similarly because the same concentration and type of epoxy resin was used in the fibers.

Fiber posts are bonded within the root. Posts with more components that mimic dentin require less force concentration between the components and the root during function. These posts have a lower modulus of elasticity than rigid posts made of metal or zirconia, thus preventing root fractures.[30] Air abrasion and surface morphology modifications of fiber posts with hydrogen peroxide and hydrofluoric acid significantly improved the interfacial strength between them and core materials.[31]

Polyethylene woven fibers are coated with a dentin bonding agent, packed into the canal, and require light polymerization to become rigid, acting as a post. Comparative studies of fiber-reinforced posts reported a lower incidence of vertical root fractures.[32,33]

These posts showed increased strength after adding a small-sized prefabricated post. They also protect the remaining tooth structure.[33] Polyethylene woven fiber posts are an adequate choice for teeth that have undergone apical resection and perform better in narrow canals than glass fiber-reinforced posts.[34] Polyethylene woven fiber posts exhibited less microleakage than zirconia posts.[35]

Glass fiber posts have a lower modulus of elasticity than carbon/graphite fiber posts. Different types of glass are available on the market:

E-Glass: Contains silicon dioxide, calcium oxide, barium oxide, aluminum oxide, and other oxides in an amorphous phase.

High S-Glass: Has a similar amorphous phase but with differing composition.

Fiber-Reinforced Composite Posts: Composed of a methacrylate composite matrix with parallel glass fibers.

Glassix Posts: Feature a woven fiber arrangement with similar dimensions.

Mirafit White Posts: Made of glass fibers.

Luscent Anchor Posts: Composed of translucent longitudinal glass fibers within a resin matrix.

Fiber Kor Posts: Include a filled composite matrix surrounding the glass fibers, with both fibers and composite resin making up 29% by weight.[7]

Quartz fiber posts: Aesthetic posts with a central core of carbon fiber bundles surrounded by longitudinally arranged quartz fibers.[7]

Aesthetic Plus Post: Composed entirely of quartz fibers.

Light Post: A translucent quartz fiber post designed to facilitate light-curing materials for luting.

Ceramic posts: Made from zirconia, aluminum oxide, or glass-ceramic combinations.[36]

Zirconium posts: Polychrystalline ceramics derived from zirconium oxide, widely used for their balance of strength and aesthetics.

Aluminum Oxide Posts: An alternative to zirconia posts for situations requiring lower strength.

Glass-Ceramic Posts: More translucent than zirconia and aluminum oxide, offering better aesthetics.

Advantages of ceramic posts include their natural tooth-like appearance, optical properties that mimic enamel, biocompatibility, resistance to breakage, stress distribution like dentin, long-term performance, and preservation of tooth structure.[37]

However, ceramic posts require specialized adhesive agents for stable bonding, precise preparation, and careful placement. Unlike fiber posts, which can be easily trimmed and adapted, ceramic posts demand sufficient dentin for support.[38]

Hybrid Posts

Hybrid posts combine materials like metal and ceramics to offer aesthetic and biocompatibility benefits.

Fiber-Resin Posts: Combine flexibility from fibers to mimic natural elasticity, reducing fracture risks, while the resin layer provides aesthetics.[39]

Metal-Fiber Hybrid Posts: Typically used for posterior teeth, they combine the strength of metal with the flexibility of fibers for better stress distribution compared to conventional metallic posts.[40]

Resin-Based Hybrid Posts: Suitable for anterior teeth, balancing aesthetics and strength.[41]

Despite their advantages, hybrid posts may be costlier due to complex manufacturing processes and challenges in bonding between materials. These posts are primarily suitable for anterior and premolar teeth.

Considerations for Restorative Planning of Endodontically Treated Teeth

The amount of remaining tooth structure, physical changes, anatomical position of the tooth, post length, ferrule, rigidity, occlusal loading forces, restorative materials, and aesthetic requirements are key factors in selecting materials and techniques for the restorative planning of endodontically treated teeth.[3]

Although numerous in vitro and in vivo studies exist, it remains unclear which post system is the best in terms of material choice. Some researchers prefer posts with a high modulus of elasticity, while others recommend posts with a modulus similar to dentin.[42-44]

Finite element analysis studies observed stress distribution on endodontically treated teeth with different post materials. Glass fiber posts showed the least stress, while prefabricated stainless steel and titanium posts produced higher stresses on the tooth structure.

Materials with a modulus of elasticity close to enamel or dentin distribute stress more effectively in restored teeth. CAD-CAM posts made from various materials, such as fiber-reinforced composite, nanoceramic, and zirconia, demonstrated no significant differences in stress distribution.[45]

Titanium posts and cast metal post-and-core systems reported better stress distribution than prefabricated metallic posts. Some studies reported that carbon posts distribute stress better than fiber posts.[46,47]

Studies suggest that short posts have a higher chance of failure, so they should be inserted in the root canal as far as possible, with 3 mm gutta-percha left in the apical sector.[48,49] According to post diameter, investigators reported that the posts with a wider diameter have a higher chance of causing root fracture.[7] Metal posts that require cements for their insertions do not strengthen the root. Otherwise, bonded posts may strengthen the root, but after a period of time, the resin bond between dentine and post is lost and leads to root weakness.[50] If the remaining ferule tooth structure is 1.5-2.0 mm in the occlusal direction, it will be sufficient to restore the crown with the post within the root canal.[51] There is no report that the rigidity of the post influences the survival of an endodontically treated tooth.[52]

It has been shown that in cases of ineffective endodontic root canal treatment and the need for retreatment, metal and fiberglass posts are easier to extract than ceramic posts and zirconium posts.[53]

Future Directions

For a successful post-and-core system, clinicians should consider proper obturation, post space, length, ferrule design, and preservation of root dentin. Treatment planning should address all clinical parameters to meet patient needs. New in vitro and in vivo (long-term longitudinal) studies may be essential to evaluate which post-and-core system is more adequate and resistant against occlusal force in teeth that are endodontically treated. Developing standard protocols for post-and-core system applications is needed.

Further research is needed to determine which new materials and advanced technologies are most effective for post-endodontic restoration. Future investigations should focus on enhancing the understanding of the relationship between root canal treatment and restoration using ceramic posts and zirconium posts to achieve more retentive crown restorations.

Conclusion

This review highlights the critical relationship between root canal treatment and crown restoration reinforced with post-and-core build-up. Despite the numerous systems used today for restoring teeth after endodontic treatment, no universal system of post-and-core build-up restorations achieves optimal features. Metal posts can cause root fractures due to the high concentration of stress, which is a recent concern. Fiber-reinforced composite posts, ceramic posts, and zirconium posts are recent advances. As advancements in root canal treatment evolve along with post-endodontic restoration, more studies should be focused on understanding which posts are more effective in preventing tooth failure.

Competing Interests

The authors declare that they have no competing interests.

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