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Review Article

# Endodontically Treated Teeth Restoration: A Comprehensive Overview

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## Abstract

The restoration of endodontically treated teeth (ETT) indeed poses several challenges in dental practice. It includes procedures that are associated with several areas in the dental field, such as endodontics and restorative dentistry. The goal of restoration of endodontic-treated teeth is to prevent micro-leakage, protect teeth from fracture, and replace the structures lost during caries control or trauma. The restorative treatment plan of endodontic-treated teeth depends on many factors but mainly the quantity and quality of the residual tooth structure. The aim of the review is to benefit the dentist determine the restorative treatment needed for endodontically treated teeth.

**Key words:** Composite resin, Cuspal-coverage restoration, Endodontically treated, Post, Teeth restoration

## INTRODUCTION

The goal of root canal treatment is the removal of necrotic and contaminated tissue, followed by canal obturation to avoid bacterial proliferation within the pulpal canal or periapical tissue.[1] Root canal restoration is considered one of the most debatable and challenging treatments in dental clinics since it involves several restorative specialties such as endodontics, prosthodontics, and operative dentistry.[2] Restoration of an endodontically treated tooth is the procedure of restructuring the tooth that has undergone root canal treatment to avoid additional tooth damage and minimize the coronal leakage.[3] The restoration involves cleaning, canal sealing, and the placement of an appropriate coronal seal restoration. Inadequate or missing restorations can lead to root canal failure or tooth fracture.[4]

Endodontically treated teeth (ETT) must be treated differently than vital teeth because of altered tissue physical characteristics as a result of loss of tooth structure, dentin dehydration, collagen alteration, loss of proprioception, and the influence of irrigate solutions on dentin.[5,6]

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Dentine dehydration and collagen alteration after endodontic treatment of teeth affect the biomechanical properties of dentine. The observation that ETT have a lower moisture content compared to the vital teeth has been reported in dental literature, with estimates often suggesting around a 10% reduction in moisture content. This change is believed to be primarily due to the removal of the dental pulp during root canal therapy, which disrupts the internal moisture supply to the dentin. Also, heat created during treatment leads to dentine dehydration.[5,7] Researchers report that dentin dehydration induces cracks at the root surface that can propagate under cyclic loading, leading to root or tooth fractures.[8] Non-vital teeth show a reduction of 30% in proprioception sensation, making the tooth less capable of identifying an increase in loading force, leading to a decrease in normal defense response and increased stress on the ETT, making it more susceptible to cracks and fractures.[7,9] The intracanal irrigations (ethylenediaminetetraacetic acid and sodium hypochlorite [NaOCl]) exposed harmful effects on the organic–inorganic ratio of the dentin, leading to a decrease in the microhardness, flexural strength, and modulus of elasticity of the dentin.[10] Medication (calcium hydroxide) used during root canal treatment reduces the fracture strength of dentin and makes dentine prone to fracture.[11]

Loss of tooth architecture is considered a major cause of tooth weakening in ETT that affect the structural stability and biomechanical properties of the tooth and increases

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the risk of tooth or root fractures. The strength of root canal-treated teeth decrease by 5% after access opening, instrumentation and obturation, 46% after the loss of one marginal ridge, and 69% after the loss of two marginal ridges compared to that of intact vital teeth.[8,12]

The best timing for performing coronal restoration of ETT is before (temporary crown) or immediately after completing endodontic treatment. When this is possible, the prognosis of teeth with final restorations received by patients immediately after root canal treatment is better than that of teeth receiving temporary restorations. Literature states that teeth with temporary restorations are more prone to coronal leakage compared to those with definitive or permanent restorations. In some situations, such as the present of large pre-operative periapical lesions (more than 2 mm), delay the definitive restoration is suggested for the regression of periapical lesions, so using bonding restoration as a temporary restoration is recommended that can act as a barrier preventing salivary contamination.[2,13] In the literature, there are controversial opinions regarding the effect of the dimensions of the pre-operative lesion on root canal treatment success. Some reported that there is no difference while others claim that a bigger lesion has a detrimental impact on the outcome. In uncertain prognosis, it might be prudent to let for a longer time for evaluation until there is evidence of clinical and radiographic signs of curing before placement of the final restoration.[13,14]

Comprehensive evaluations of both endodontical and periodontal situations must be evaluated before any restorative treatments. The endodontic treatments must have good coronal and apical seals, absence of exudates, no sensitivity to pressure, no apical sensitivity, absence of fistulas, and no active inflammation. Periodontal status should be stable before finalizing the definitive restorations.[15]

Planning the restoration of an endodontically treated tooth before starting root canal treatment is indeed a prudent approach in modern dentistry. This forward-thinking strategy ensures a comprehensive treatment plan that considers not only the endodontic therapy but also the long-term structural integrity and functionality of the tooth, and also it benefits to determine the restorability and prognosis of the teeth, which can help in proposing the patient with different treatment options with a clear prognosis for each one. The primary objective of restoring ETT is to return the tooth to its original form (function, esthetics, and structural integrity) and provide a good coronal seal. There is a direct relationship between remaining tooth structure and fracture resistance. According to the Nagasiri and Chitmongkolsuk study, greater remaining tooth structure means greater longevity for the teeth.[16] The restorative treatment plan for an endodontic treatment tooth is affected by several factors, such as the quality and quantity of residual tooth structure, remaining adjacent teeth, occlusion, and the planning of the restoration to be placed on the tooth. It is essential to achieve a stable and functional occlusion, choose the appropriate restoration material and design, and ensure a successful treatment outcome.[17]

The aim of this review is to help the dentist choose a proper restorative treatment for different situations of endodontically treated teeth.

## RESTORATIVE TREATMENT OF ENDODONTIC TREATED TEETH (INTRACORONAL AND CORONAL RESTORATION)

A root canal post, also known as a dental post, is a small rod made of metal, ceramic, or fiber that is placed inside a tooth after a root canal treatment if the residual tooth structure is not sufficient. Post helps to retrieve an existing tooth that has been lost by decay or trauma, provide support, and retain a dental restoration that is on top of the tooth.[14]

The decision on the placement of a post in ETT involves careful consideration of various factors, including the size, shape, and curvature of the root canals. The general guideline you've mentioned, placing the post in the largest and less curved canal. The preparation for the post should be conservative, focusing on removing only what is necessary to accommodate the post without compromising the structural integrity of the tooth to avoid weakening the tooth and reducing the risk of root fracture. As a general guideline, the length of the post should be at least equal to the crown length to provide adequate support. The post should ideally extend about two-thirds (2/3) of the length of the root in ETT, but this also depends on the root length and anatomy. The diameter of the post is critical; it is often recommended that the post diameter should not exceed one-third of the root's diameter to minimize the risk of root fracture. It is essential to ensure that sufficient dentin thickness is maintained around the post to provide strength to the root structure.[18] However, leaving at least 3 mm of gutta percha at the root's tip after root canal treatment is a common recommendation. This practice is associated with maintaining an adequate apical seal, which is crucial for the long-term success of endodontic therapy.[18]

The treatment plan decision for post-placement mainly depends on the quantity and quality of residual tooth structure, but there are other functional factors that can

significantly influence the treatment plan, such as the situation of adjacent teeth, occlusion, and parafunctional habits.[1,14,17]

The minimal thickness of the cavity wall to withstand the functional forces during normal biting and chewing without risk of fracture is 1 mm; the minimal height of a cavity wall to retain a dental restoration is 1.5 mm (ferrule effect). During caries control, this information plays a vital and crucial role. The goal of caries control is to excavate all caries tooth structure and preserve healthy tooth structure to provide support for the restoration, but at the same time, we have to remove any dentine wall less than 1-mm thickness to avoid tooth fracture during functional loads.[15,16] The amount of remaining healthy axial walls plays an important role in the fracture strength of root canal-treated teeth and the determination of the treatment plan. The more remaining tooth structure after caries control can improve the teeth fracture resistance and minimize the restorative treatment need.[19] The teeth were classified based on the residual amount of healthy tooth structure into five classes. Class I describes the access root canal preparation with all four axial walls remaining. Class II describes the loss of one wall of the cavity. Class III represents two cavity walls remaining. Class IV describes one remaining cavity wall, and Class V describes a decorated tooth without a cavity wall remaining. Based on this classification, a restorative treatment plan will be proposed to the patient [Table 1].[18]

Anterior teeth with two walls or more do not need an intraradicular post, and the core and tooth can be restored directly through composite resin restoration, unless full coverage or veneer restoration is needed for esthetic reasons. In cases where remaining Anterior tooth structure is insufficient to support a crown on its own (remaining tooth structure is <2 wall remaining), an intraradicular post needs to be placed within the root canal to provide additional support and retention for the core restoration and eventual crown. This post is typically made of materials such as metal or fiber and is anchored within the root canal space. Non-metal posts and a full ceramic crown are preferable for esthetic reasons [Table 2].[18,20]

Posterior teeth that have been endodontically treated based on the recommendation of the American Association of Endodontists should be protected by cuspal coverage restorations to preserve the tooth's integrity against occlusal forces and helps in preventing microleakage and secondary decay. The intraradicular post and core are not required for posterior teeth with two walls or more remaining, but if the posterior teeth have lost a significant coronal structure, more than two wall-missing teeth will require an intraradicular post and core.[20,21]

In situations where an endodontically treated tooth is subject to increased occlusal forces, the use of an intraradicular post followed by a crown can be a prudent choice, regardless of the residual tooth structure. This approach is particularly advisable in the following scenarios: Endodontically treated tooth without that, a tooth stands alone without the support of adjacent teeth when an endodontically treated tooth is selected as an abutment for a fixed bridge or other types of dental prosthesis and patients with bruxism or clenching habits. An intraradicular post plays a significant role in anchoring the coronal restoration and enhancing the distribution of forces in ETT.[11]

There is some controversial opinion in the restorative treatment of root canal-treated teeth; some literature reports that posterior ETT with Class I and Class II can be restored by direct bonding restoration.[22] A systematic review and meta-analysis reported that there is no statistically significant difference in terms of survival

**Table 1: Classification in endodontic treatment depending on the number of remaining axial cavity walls with thickness>1 mm**

| Classes according to number of axial walls | Remaining cavity walls |
|---|---|
| Class I | 4 remaining cavity walls (access cavity) |
| Class II | 3 remaining cavity walls |
| Class III | 2 remaining cavity walls |
| Class IV | 1 remaining cavity walls |
| Class V | No remaining cavity wall |

**Table 2: Tooth restoration requirement after endodontic therapy according to type of tooth and remaining coronal structure**

| Type of tooth | Coronal structure | Requirement |
|---|---|---|
| Anterior teeth | - Two walls or more remaining with thickness 1 mm or more and high 2 mm or more (Class I, II and III) | Not need an intraradicular post and core and tooth can be restored by composite restoration |
| | - <2 walls remaining with thickness 1 mm or more and high 2 mm or more (Class IV and V) | Intraradicular post and core and full crown |
| Posterior teeth | Two walls or more remaining with thickness 1 mm or more and high 2 mm or more (Class I, II, and III) | Not need an intraradicular post and core and tooth need cuspal coverage |
| | <2 walls remaining with thickness 1 mm or more and high 2 mm or more (Class IV and V) | Intraradicular post and core and cuspal coverage |

between indirect (coronal coverage) and direct (composites restoration) restoration for endodontic-treated teeth. Direct restorations were used in those studies when at least two cavity walls remain (one marginal ridge).[12,23] Other meta-analyses reported weak advice for indirect restorations for ETT, especially when the tooth has two walls or more remaining.[24]

Endocrowns indeed represent a viable alternative to conventional post-core and crown restorations for endodontically treated posterior teeth, particularly in certain cases such as Class IV and V cavities. The decision between using an endocrown versus a traditional post and crown depends on various factors, including the amount of remaining tooth structure, the tooth's position, occlusal forces, and esthetic considerations. One of the key benefits of endocrowns is their stress distribution. In endocrowns, the stress is concentrated at the root's outer surface, more closely mimicking the natural distribution of forces in an intact tooth. Conversely, in post-core crowns, the stress is often concentrated at the root canal's inner wall, which can predispose these teeth to root fracture, particularly if the remaining tooth structure is minimal.[25]

## CONCLUSION

The intraradicular post and core are required for all endodontic treatment teeth with <2 walls remaining; crown restoration will be advisable for anterior teeth with endodontic treatment if the remaining wall is less than two walls. According to the American Association of Endodontists, all posterior ETT should receive cuspal coverage restorations.

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