



The Different Designs Used for the Restoration of Endodontically Treated Teeth. A Review Article



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Abstract:

Adequate restoration of endodontically treated teeth (ETT) begins with an appropriate understanding of their physical and biomechanical properties. Treatment quality and integrity of the remaining tooth structure should be conserved cautiously. Although many new restorative materials and techniques have become available in the last years, some basic concepts in restoring ETT remain the same. **Aim of the work:** The aim of our review is to highlight different designs used for reconstruction of ETT. **Methods:** we searched The PubMed database for study reporting reconstruction of ETT. **Results:** We found several designs used for the restoration of ETT. For example, fiber post, endocrown, sharonlay. Each design should be selected according to the status of the remaining tooth structure. The most popular design was fiber post followed by endocrown. Sharonlay is a novel design was introduced in the 2015 reconstruction of ETT however, the available research on it were few, and the restoration was fabricated from metal. The operation skills are essential elements for determining the longevity of adhesive bonded indirect restorations.

Introduction

Reconstruction of endodontically treated teeth ETT is a tremendous challenge in restorative dentistry.

This is because the coronal part of the tooth is usually partially or totally lost by caries, erosion, abrasion, trauma, endodontic access, or previous crown restorations.¹ Restoration of ETT is complex, and the following parameters should be considered: tooth condition, tooth position in the jaw, tooth anatomy, function occlusion, and rehabilitation planning.^{2,3} knowledge of the physical requirements, long term prognosis and understanding of the limitations of available materials are essential for ideal restoration for ETT.⁴ Extracoronary restorations should be placed on most root canal treated posterior teeth to improve their long-term survival.^{5,6} Some data denote that intact posterior teeth except for the access opening can be restored satisfactorily with direct composite resin instead of a crown.^{5,7,8} Maximum conservation of sound tooth structure and the choice of good restoration with mechanical properties similar to dental structure provide greater longevity of the tooth-restoration complex.⁹ Adhesive procedures allow the clinician to conserve instead of remove dentin.¹⁰ Polesel (2014) recommended three therapeutic modalities for restoring single posterior ETT, including; direct and indirect adhesive restorations and conventional crown.¹¹ The amount of residual health tooth structure is the most critical factor affecting the therapeutic option.⁹ The aim of our review is to highlight different designs used for reconstruction of ETT.

Methods:

We searched the PubMed database for the reconstruction of endodontically treated teeth, and the used search terms were “root canal treated teeth”, “non-vital teeth”, “devitalized teeth”, “reconstruction”, “restoration” The search strategy for PubMed is described in Table 1. The research results were imported in EndNote (X9, Clarivate Analytics), and duplications were deleted.

Table 1. Search Strategy PubMed.

Search	Query
#3	Search #1 AND #2
#2	Search (reconstruction *[tw] OR restoration*[tw])
#1	Search (root canal treated teeth *[tw] OR non-vital teeth *[tw] OR devitalized teeth*[tw])

Eligibility Criteria:

Inclusion criteria: all studies (in-vitro, in-vivo) that discussed how to reconstruct ETT were selected for exclusion criteria: we ignored the studies that used direct restoration only to reconstruct ETT. Also, studies that used metallic restoration except for sharonlay as it is a novel design and only fabricated from metal. Finally, we excluded studies if we cannot access the full text.

Results

Data Collection and Processing

We extracted data from the selected studies and found several designs used for the restoration of ETT. For example, fiber post, endocrown, sharonlay. Each design should be selected according to the status of the remaining tooth structure. The most popular design was fiber post followed by endocrown. Sharonlay is a novel design was introduced in the 2015 reconstruction of ETT however, the

available research on it were few, and the restoration was fabricated from metal.

The operation skills are essential elements for determining the longevity of adhesive bonded indirect restorations.¹¹

A- Fiber post:

Traditionally, metallic posts have been used to build up ETT.¹¹ Tooth-colored post systems were developed due to increased esthetic needs and possible problems of metallic posts, including post-fracture, root fracture, and crown and or post-loss of retention.^{1,12,13} The technical development of fibre-reinforced materials, including structure, shape, and optical properties of the post, has resulted in material development to overcome many drawbacks of metallic posts. Because of the esthetic appearance of esthetic posts, failure mode and clinical performance of fibre-reinforced posts, they are preferred over metallic posts.^{14, 15} Fiber-reinforced composite (FRC) resin material has been shown to have satisfactory clinical results in various clinical situations¹⁶⁻¹⁸ The essential function of the post is to retain a core in ETT with severe coronal destruction.^{3, 19} An ideal post should have the following characters: mechanical properties similar to dentin, maximum retention with minimum dentin removal, even functional stresses distribution within root surface, esthetic matching with the final restoration and surrounding tissue, minimum stress during insertion and cementation, resistance to displacement, easy retrievability, ease of use, safety, reliability, and reasonable price.^{20,21} Several authors have pointed out that root canal posts with low stiffness result in more stress distribution.^{15,22,23} Choosing the proper post and core systems is challenging. Therefore, it should be planned by knowledge of their indications, usefulness and shortages, in addition to the quality and quantity of remaining tooth structure and esthetic requirement.^{18, 3,24} Incorporation of various advantageous properties of the post (ferrule effect, diameter, length, luting cement etc.) is paramount for the long-term success of such restorations.²⁵ A fiber post is composed of reinforcing fibers immersed in a resin polymerized matrix. Popular fibers are fabricated from carbon, glass, silica, or quartz but the kind, volume content, and distribution of the fibers and the matrix are different among fiber post systems.²⁶

The mechanical characteristics of prefabricated FRC posts for example greater fatigue resistance, low elastic modulus similar to that of tooth dentin, rely on several factors. These factors include the kind, content, and direction of fiber used as well as the type of used matrix.²⁶ **Cagidiaco et al., (2008)** evaluated the clinical outcome of ETT restored with fiber posts. They concluded that; the usage of the fiber post prevent failure, particularly in case of severe coronal damage. Debonding is the prevalent failure occurring with fiber posts.²⁷ **Hafiz et al., (2020)** stated that the usage of fiber post followed by zirconia crown is a treatment option which enhances the longevity of ETT.²⁸

B Endocrown:

A shift in therapeutic modalities toward more conservative ones is noticed, and the requirement for traditional posts and cores has become less obvious.²⁹⁻³¹ Ceramic indirect restorations (inlay and onlay) and endocrowns were launched as an alternative option for restoration of ETT,

based on the amount of remaining tooth structure.³² A postless designs used to restore ETT involves using the pulp chamber to extend the crown itself, forming a monoblock containing the crown and core build-up in a one piece. Endocrowns were emerged by Pississ in 1995.³³ It is introduced as a one-piece overlays fabricated from composite or ceramic to reconstruct the coronal portion of ETT. These teeth should have the following characters, a supracervical butt joint, conserving maximum enamel to enhance boning and extended within the pulp chamber with a small extension into the root canal.³⁴ This design has micromechanical retention as it extends from the internal part of the pulp chamber to the cavity margins. On the other hand, micro retention is obtained by adhesive cementation.³⁵ It is composed of a circular butt-joint margin and internal retention cavity within the pulp chamber.^{36,37} This design provides minimal invasive preparations with the protection of the existing tooth structure.^{38, 39} The supragingival placement of the cervical margin preserves the marginal periodontium, simplifies impression making, and conserves the remaining tooth structure.^{37,40,41} reasonable price and less clinical time are the benefits of endocrowns.^{29, 30,42} Endocrown is a reliable alternative to reconstruct root canal treated supra erupted posterior teeth.³⁸ Its clinical use can also be justified, particularly in ETT with short clinical crowns. Also, in teeth where root configuration prevents the use of post and core.^{42, 43} Moreover, it is suitable for cases where there is a great loss of tooth structure, reduced vertical dimension, small interproximal space and conventional rehabilitation where post and crown are not possible.^{37, 43, 44} The development of ceramic technology, particularly dental CAD/CAM and adhesive cementations, have increased opinions to create ceramic endocrowns with excellent biocompatibility and mechanical features.⁴¹ In addition, it is a simple technique, less clinical time consuming, with better acceptance.⁴⁵ Therefore, it is considered a superior option among the various treatment alternatives.^{32,38} Endocrown could give greater retention, particularly especially where more than half of the remaining tooth remains with decreased load and lateral stresses.^{46, 47} Forces are composed of compression dispersed over the cervical butt joint and shear force over axial walls therefore moderating the load on the pulpal floor. Perfect preparation without undercuts and with diverging walls, voidless rubber base impression, great laboratory support, adapting to strict cementation protocols, and perfect finishing and polishing are mandatory steps for the success of ceramic endocrowns.^{39,40, 43} **Yousief et al., (2020)** conducted comprehensive research reviewing the advantage of end crowns compared to full coverage crowns used to restore badly decayed posterior teeth.⁴⁸ They found that endocrown is a simple procedure that can be completed in one visit that is impossible for cases with full coverage crowns after post and core fabrication. Additionally, endocrowns with butt joint margin provide better stress distribution. Therefore, it reduces the applied force on the pulpal floor. **Govare and Contrepolis (2020)** stated that endocrown is a reliable substitute to conventional crown supported post and core for restoration of posterior ETT.

Provided that; the guidelines for both preparation and cementation technique should be followed.⁴⁹

A- Sharonlay

A new treatment modality named “sharonlay” is defined as an onlay with a post extension indicated for premolars with proximal caries where the cuspal damage is ideal for onlay preparation. The post extension enhances the retention of the onlay, especially with the small sized premolars. The post also reinforces the cervical neck of the ETT, minimizing the horizontal fracture at the neck of the tooth.⁶ Hence, sharonlay counters the compressive and tensile loading on the endodontically treated premolars. It has been tested clinically for more than a decade. Evaluation of these restorations after 10 years shows promising long-term success. However, the selection of an appropriate case is essential for the final success of the restoration.⁶ Sharonlay may also be indicated in a multirrooted teeth mainly for retention, particularly with short clinical crown which preclude using crown or endocrown.⁵⁰ **Chandra et al., (2016)** found that the fracture resistance of sharonlay was more outstanding compared to metal onlay with ready-made metallic post and metallic onlay over ETT.⁵¹

Conclusion:

There are several designs used for the reconstruction of ETT. The talented operator should select the best option that provides best outcome.

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