Egyptian Prosthodontic Association
(EPA Newsletter)

# Selecting appropriate design and material to restore endodontically treated teeth

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Endodontically treated teeth (ETT) exhibit a few but notable differences in mechanical properties compared to vital teeth. [1], the substantial loss of hard tissue due to decay, cavity preparation, and the entire root canal treatment process significantly increases the risk of tooth fracture [2,3]. Furthermore, absence of intradental receptors which buffer the excessive forces [4].

Choosing the right design and materials is crucial for the durability and functionality of the restoration of (ETT) [5]. the extent of tooth structure loss, tooth's position and chewing forces are all considered factors when determining the most appropriate restorative approach [6] (Figure 1).

## I. Choice of Restoration Type and Material for ETT

### A. Partial coverage crowns and veneers

In the posterior sector, when enough tooth structure remains, the bonded partial crown, sometimes called an overlay or occlusal veneer, provides an ideal compromise between cuspal coverage, tissue preservation, and esthetics.

The preparation of partial crowns can be extended using a veneer preparation on the buccal surface for better esthetic, "buccal–occlusal veneer" esthetics (Figure 2) [7] that is might be fabricated by Machinable composite [8]. However, it exhibits a low elastic modulus and relatively prone to deformation, placing greater stress on the adhesive joint and leading to a higher degree of marginal leakage [9] **(Figure 2).**

Regarding ceramic materials, **Feldspathic** should not be the first choice for fabricating partial crowns on posterior ETT [10], however, **Lithium disilicate** and polymer-infiltrated ceramic network **(PICN)** are highly recommended due to their greater elastic modulus [10,11]. Also, Zirconia-reinforced lithium silicate **(ZLS)** could represent an interesting compromise as it combines the beneficial properties of different materials.

### D. Full coverage crowns

Full-coverage crowns are proven as a viable therapeutic option in many cases of damaged ETT [12]. The success rate seems to increase with the number of remaining walls, reaching 100% success with four walls remaining [13] .

**Metal–ceramic** crowns have been widely used over last decades, now all-ceramic crowns seem to be an interesting alternative, having sufficient strength to withstand functional forces, along with esthetic benefits. However, **Feldspathic and silica-based ceramics** are only deemed suitable and safe for anterior restorations [14].

**Monolithic zirconia** crowns have gained popularity due to their superior mechanical properties, which allow for reduced tooth preparation compared to bi-layered restorations. Their high flexural strength enables them to be milled even with a reduced thickness. In light of these details, the practitioner should certainly consider this as an option for restoring posterior ETT. However, the highly opaque appearance restricts its esthetic use in the anterior region. For a more natural aspect, **lithium disilicate** is preferred anteriorly in layered forms to enhance translucency [15].

### C. Endocrowns

Endocrowns are described as adhesive monolithic restorations anchored in the pulp chamber, exploiting the micromechanical retention properties of the pulp–chamber walls [16]. The difference with a traditional full crown lies in the fact that no additional restorations (such as a post or composite build-up) are associated with it, reducing the number of clinical steps and preserving the maximum amount of sound tooth tissue. The core and the crown are assembled in one single component. Given that the stiffness mismatch between dentin, luting cement, and the restorative system can affect stress distribution, the monoblock nature of endocrowns can better support stress loading compared to the multi-interface nature of conventional restorations [17]. Despite the growing popularity of endocrown restorations, it has been noted that endocrowns fail more frequently when placed on premolars and incisors, likely due to their smaller adhesion area and greater crown height compared to molars. Additionally, these teeth are subjected to more non-axial forces than molars, which may also impact fracture resistance. Therefore, endocrowns **cannot be currently recommended for use on incisors and premolars** [7].

Regarding the choice of materials, **machinable composites and PICN** have advantageous characteristics for endocrown fabrication due to their modulus of elasticity, which closely matches that of dentin [15]. Since debonding has been reported as the most common cause of failure more than the risk of fracture, materials with the highest adhesion values and esthetic properties, such as **lithium disilicate**, are the best choice [17].

## II. Post or No Post?

Root canal posts have been recommended for anchorage and the retention of the core build-up and final coronal restoration. However, with advancements in dentin bonding, the relevance of their use is currently being questioned because of the additional removal of sound tissue to fit the post intra canal, which consequently affects the overall biomechanical behavior of the ETT (Figure 4). [18]. Therefore, the extra retention provided by a post must be weighed against the loss of healthy tooth tissue [19,20].

In the presence of a ferrule, studies strongly suggest that posts are unnecessary for restoring ETT. A ferrule is defined as the remaining natural tooth structure between the apical extension of the tooth/core junction and the crown preparation margin [21]. Clinically, it is widely accepted that a ferrule height of 1.5-2 mm is only beneficial if the remaining dentin is at least 1 mm thick and the longer the ferrule, the better fracture resistance [22]

Subsequently, a circumferential ferrule can be considered as the first ideal solution for restoration of ETT and should be sought whenever possible [23]. Still, it is not possible to secure circumferential ferrule in all clinical cases. Therefore, the clinical decision must balance the benefits and risks of achieving an "all-around" uniform ferrule (Figure 5) [24]. The potential complications of a crown-lengthening procedure include damage to adjacent teeth, the reduction of attached gingiva width, tooth sensitivity, and the risk of postoperative tooth recession [25].

When no ferrule can be obtained, the placement of a post still seems beneficial on **anterior teeth and premolars** due to the higher risk of mechanical failure in this region [5,26]. Regarding **molars**, which have a larger bonding surface due to the size of their pulpal floor, the placement of a post is not justified, even in the absence of coronal walls [5,6].

### A. No post required: Choice of material for composite build-up

If the practitioner chooses not to use a post, two solutions exist for the restoration of the tooth core: the placement of an endocrown or the insertion of an intermediate core material onto which the full coverage restoration will be placed [27,28]. For ETT in particular, excessive polymerization shrinkage on a mechanically weakened structure can only be unfavorable. In this context, "bulk-fill" composites have been recommended for core build-up [29].

Recently, advanced **short-fiber-reinforced composite (SFRC)** materials have been described as providing structural and chemical reinforcement to weaker teeth to prevent fractures in ETT [30,31]. SFRCs are

recommended for the biomimetic replacement of dentin in larger cavities and ETT, as they enhance mechanical retention, inhibit fracture propagation, and establish robust chemical bonding between glass fibers and the resin matrix. However, to prevent hydrolysis between the fibers and the matrix fiber-reinforced composite should always be covered with a classic composite [30,32]

### B. Post required: which one is more favorable

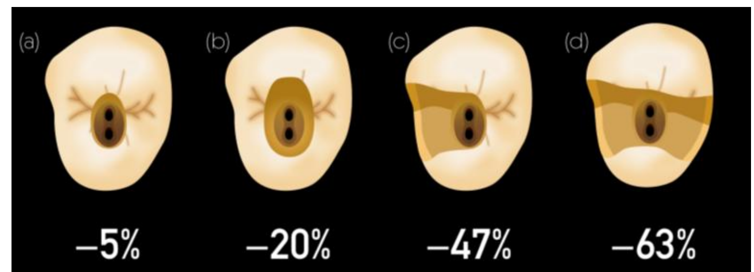
Prefabricated fiber-reinforced posts have become increasingly favored for clinical use over cast posts. This shift in preference could be attributed to improved esthetics and reduced treatment times. Furthermore, the similarity in the elastic modulus between fiber posts and dentin may contribute to a decreased risk of root fractures. Given that the mechanical properties of the entire system, encompassing the post, cement, and dentine, should be uniform, utilizing fiber posts cemented and restored with composite resin material is likely to result in satisfactory performance [33]

The recent development of multi-fiber reinforced composite posts, also called bundled glass-fiber-reinforced posts or bundled posts, is promising. It does not necessitate post space preparation as it is based on a bundle of fibers that are bonded directly to the root canal. To date, only in vitro studies reported improved resistance and stress distribution compared to single fiber posts [34,35].

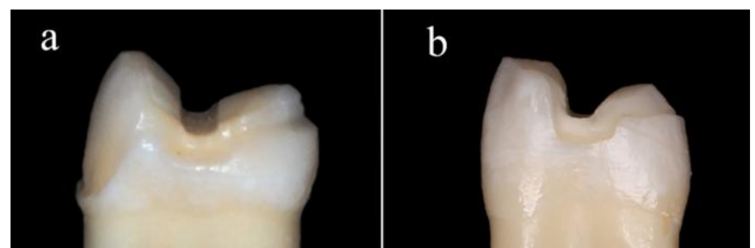
### B. Post cementation

Regarding the types of resin luting cements available, advances in adhesive technology have led to simplified protocols using self-etch or universal adhesives with adhesive resin luting cements, but also directly self-adhesive resin cement without any previous surface treatment which eliminates the challenging task of applying and rinsing phosphoric acid in the apical area of the prepared canal and shows superior bond strength values to root dentin.[36]

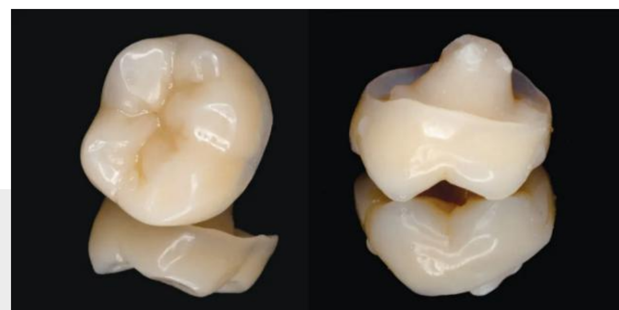
To address the problem of light inaccessibility in the canals, dual-cure resin luting cement should be used [37]. When a self-adhesive strategy is employed, the use of ethanol for the decontamination of intracanal dentin appears to be the best solution. Regarding the cleaning and conditioning of contaminated core build-up material before adhesive bonding, cleaning with pumice or air abrasion seemed superior to using polishing powder or phosphoric acid [38,39].



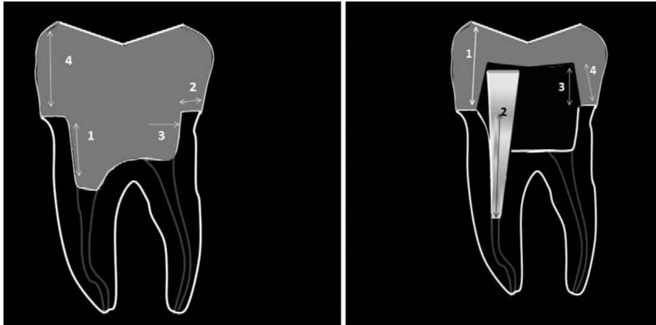

(Figure 1): Reduction in tooth stiffness after endodontic treatment (a) A conservative access cavity induces a stiffness reduction of 5%; (b) an associated occlusal cavity preparation induces a stiffness reduction of 20%; (c) an MO or OD cavity preparation induces a stiffness reduction of 47%; (d) an MOD cavity preparation induces a stiffness reduction of 63%. [6].



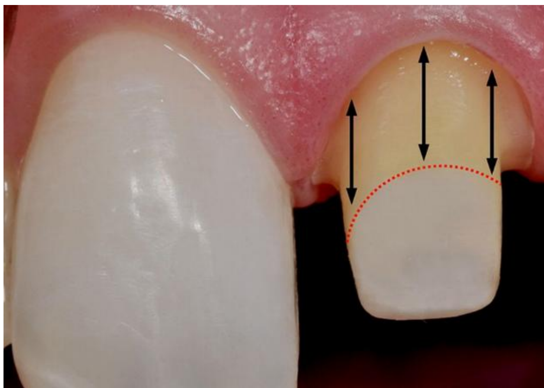

(Figure 2): Different partial coverage designs for maxillary premolars. [9]



(Figure 3) The endocrown: a different type of all-ceramic reconstruction for molars [17].




(Figure 4) Comparison of endocrowns and glass fiber post-retained conventional crowns [18].



(Figure 5) all-around uniform ferrule [24]

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