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# Endocrown preparation: Review

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**Abstract**
Endodontically treated teeth usually need special techniques to be restored and regain function. Endocrown can be an excellent option for restoring severely damaged teeth, which showed better performance in molars than premolars. It is an adhesive restoration with minimally invasive preparation. The preparation design should provide sufficient retention, stability and structural durability to the restoration. Several studies described Endocrown preparation following Bindl and Mormann technique. However, few studies described some modifications to the original preparation.

**Keywords:** Endocrown, ferrule, crown preparation

## Introduction
Endodontically treated teeth usually need special techniques to restore them. When a tooth is Endodontically treated, a considerable amount of tooth structure usually was lost due to trauma or caries in addition to the central destruction created by the endodontic access preparation. This usually makes the tooth left with insufficient sound tooth structure to support a casted restoration unaided. In addition to the complication in the subsequent restorations, there will be an increased chance of tooth fracture during mastication [1].
The choice of restoration will be thus influenced by the type of tooth; posterior or anterior, and the amount of the remaining tooth structure [1, 2].
To solve these problems a couple of clinical techniques were suggested. Anterior teeth with a limited access opening and sufficient tooth structure can be just restored by a direct restoration with no need for the placement of a crown. However, posterior endodontically treated teeth will always need cuspal coverage due to their morphological characteristics and the increased loads they are subjected to.
A tooth with substantial coronal structure loss will need core buildup and a crown. However, if the tooth structure remaining is not sufficient to retain the core an extra retentive mechanism have to be introduced [2].
Traditionally to retain the core structure in such cases a post or dowel is placed. These posts can be prefabricated posts with a direct core or a one-piece custom-made post and core. Only historically a single piece post-core and a crown are placed [1].
In the beginning, it was thought that the post and core supported the remaining tooth structure, but later studies proved that post only aid in the retention of the restoration [3]. On the contrary, actually removing from the radicular structure to place the post might weaken the root and make it more susceptible to fracture. Moreover, the presence of a post might preclude future endodontic re-treatment if necessary [1, 3].
In 1980 Nayyar *et al.* defined amalcore or coronal- radicular restorations. The procedure implied the placement of amalgam into the pulp chamber, which will enter 2-4 mm inside the canal. The pulp chamber must have enough width and depth to contribute to restoration retention [4].
The introduction of adhesives and the development of effective dentine adhesives was a changing point in the restoration of Endodontically treated teeth, which made the insertion of a radicular post a less favored option as long as there is sufficient surface area for adhesion [3].
In 1995 Pissis presented a novel technique that utilized porcelain core/crown unit a single unit. The technique was called the monobloc technique it was suggested by the author to replace the traditional metal post and core [5].

Soon enough in 1999, based on Pissis concept, Bindle and Mörmann introduced the Endocrown technique. It was described as an adhesive crown characterized as full porcelain crowns fixed to posterior Endodontically treated teeth [6]

Several studies showed high success rates of Endocrowns in molars and showed higher fracture resistance when compared to posts [7-11].

Endo crowns presented several advantages over posts and cores and crowns, they are easier to prepare and apply and requires lesser clinical time and visits. Esthetic properties are also superb [3]. Also, adhesive restorations can decrease the infiltration of microorganisms from the coronal to the apical part thus improve the clinical success of endodontic treatment [6]. Moreover, they show a great advantage in cases where posts are contraindicated due to short or narrow canals.

Endo crowns are indicated in Endo treated teeth with suitable pulp chamber depth. Nevertheless, Endocrown is contraindicated in cases with a short and narrow pulp chamber, if adhesion is not certain and if there is a very little tooth structure remaining [12].

**Preparation**

The main purpose for the use of Endocrowns is to attain an all-ceramic bonded restoration that is minimally invasive of root canals. Therefore, the Endocrown preparation is different from the conventional full coverage crowns [13]. Several studies described the endocrown preparation following Bindl and Mormann technique. While few studies described some modifications to the original preparation.

**Rational**

Endocrown is a monolithic ceramic bonded restoration with a supragingival butt joint keeping as much as possible enamel for improved adhesion. The endocrown will invade the pulp chamber only. The pulpal chamber shape and cavity warrants stability and retention. No need for further preparation. Furthermore, the pulpal floor saddle form enhances stability. [13].

**Occlusal preparation**

A minimum of 2 mm occlusal height reduction in the axial direction should be attained. The ceramic occlusal thickness is usually 3-7 mm. Studies indicated that the fracture resistance of all-ceramic restorations rises with the increase of occlusal thickness, and that endocrowns with 5.5 mm thickness fracture resistance is twice as much as ceramic crowns with 1.5 mm occlusal thickness [14, 15]

The reduction can be done by making 2mm depth orientation grooves, then with a coarse grit wheel diamond occlusal surface reduction is done. The diamond is directed along the long axis of the tooth, parallel to the occlusal plane. The diamond shape ensures the proper reduction alignment and the desired flat surface, wherein the cervical margin or cervical sidewalk is determined. Ideally, the margins should be kept supragingival allover In areas where the esthetic requirements or clinical factors requires a difference in level, a slope of no more than 60° should be between the different cervical levels. Any undermined enamel with less than 2 mm thickness should be eliminated [13, 16, 17].

The cervical sidewalk is the foundation of the restoration, the objective is to accomplish a wide, uniform, steady surface resistant to compressive stress [18]. The prepararation should be parallel to the occlusal surface to confirm stress resistance along the long axis of the tooth [13, 16, 17].

**Axial Preparation**

At this step, undercuts in the access cavity should be eliminated. A cylindrical-conical course grit diamond with an occlusal taper of 7 degrees is utilized to make the pulp chamber and endodontic access cavity continuous. Diamond should be held parallel to the long access of the tooth, excessive pressure is avoided and the pulpal floor is kept untouched. Reducing a lot from the walls of the pulp chamber will result in the reduction of their thickness and the enamel strip width. The cavity depth must be at minimum 3 mm. [13, 16, 17] The greater the extent of the pulp chamber the better the mechanical properties [19]. The recommended endocrown measurements are a 3 mm diameter cylindrical pivot and a 5 mm depth for the first upper premolars and a 5 mm diameter and a 5 mm depth for molars [13].

Bindl and Mörmann evaluated the performance of premolars and molars Endocrowns and perceived that the premolars showed more failures than the molars, that was due to the adhesion failure on them [9]. Adhesion failure in premolar endocrowns might be because of the diminished surface of adhesive bonding in comparison to molars, and the increased proportion of the prepared tooth structure to the overall crown causing higher leverage for premolars than molars [3]. Premolars having deep occlusal fissures have higher flexibility than ones that are shallow or fissuerless. Thus, premolars endocrowns must have a flatter occlusal table to minimize the crown height and the cuspal slopes resulting in shallower fissures to decrease cuspal bend and the threat of fracture during grinding [20].

In an attempt to improve the success of premolars endocrowns, the need for further intraradicular extensions might be a prerequisite [21]. Gulec and Ulusoy compared two designs with and without intraradicular extension; they found that the modified endocrown design with intraradicular extensions protected the remaining tooth structures better than the unmodified endocrown design. Regarding the stresses that occurred in enamel, modified endocrown restoration design transmitted less stress highlighting that it is a more tooth-friendly design. However, the stresses that occurred in restorative materials, maximum principle stress values were higher for the modified endocrown restoration design. They concluded that when the material volume used for the restoration increases, the material itself is adversely affected but the stress transmitted to the dental tissues is reduced [22].

**Ferrule**

The presence of ferrule in full coverages crowns supported by post and core was thoroughly investigated and well acknowledged to increase fractures resistance and fatigue cycles to failure [23-26].

Einhorn *et al.* [27] investigated the consequence of the ferrule features incorporation, on molar endocrown failure resistance. Their results showed that adding ferrule to preparations increased the dentin surface available for bonding. However, there were milling limitations in reproducing the endocrowns inner surface. Hence, it was reported that the more complex the preparation design became because of the addition of ferrule, the resultant endocrown inner surface adaptation to the preparation seemed to reduce. (Figure 1)

They concluded that ferrule-containing endocrown preparations revealed significantly superior failure loads than regular endocrown restorations; yet, there was no difference among the groups in the calculated failure stress based on existing surface area for adhesive bonding. Moreover, less occurrences of disastrous failure were detected with the

Endocrown preparations containing 1 mm of preparation ferrule design.

**Additional features**

Endocrowns are made usually from bonded ceramic restorations, taking into consideration the benefit of adhesion in the retention of the restoration. In a case report, Vinola *et al.* [28] described the use of metal-ceramic endocrown. To improve the retention and stability of this restoration additional feature was proposed to the endocrown preparation. Retentive grooves (1 mm deep) were placed on the buccal and lingual axial surfaces of the external aspect of the tooth. The metal-ceramic endocrown restoration was also sandblasted as an additional mean to enhance restoration retention.

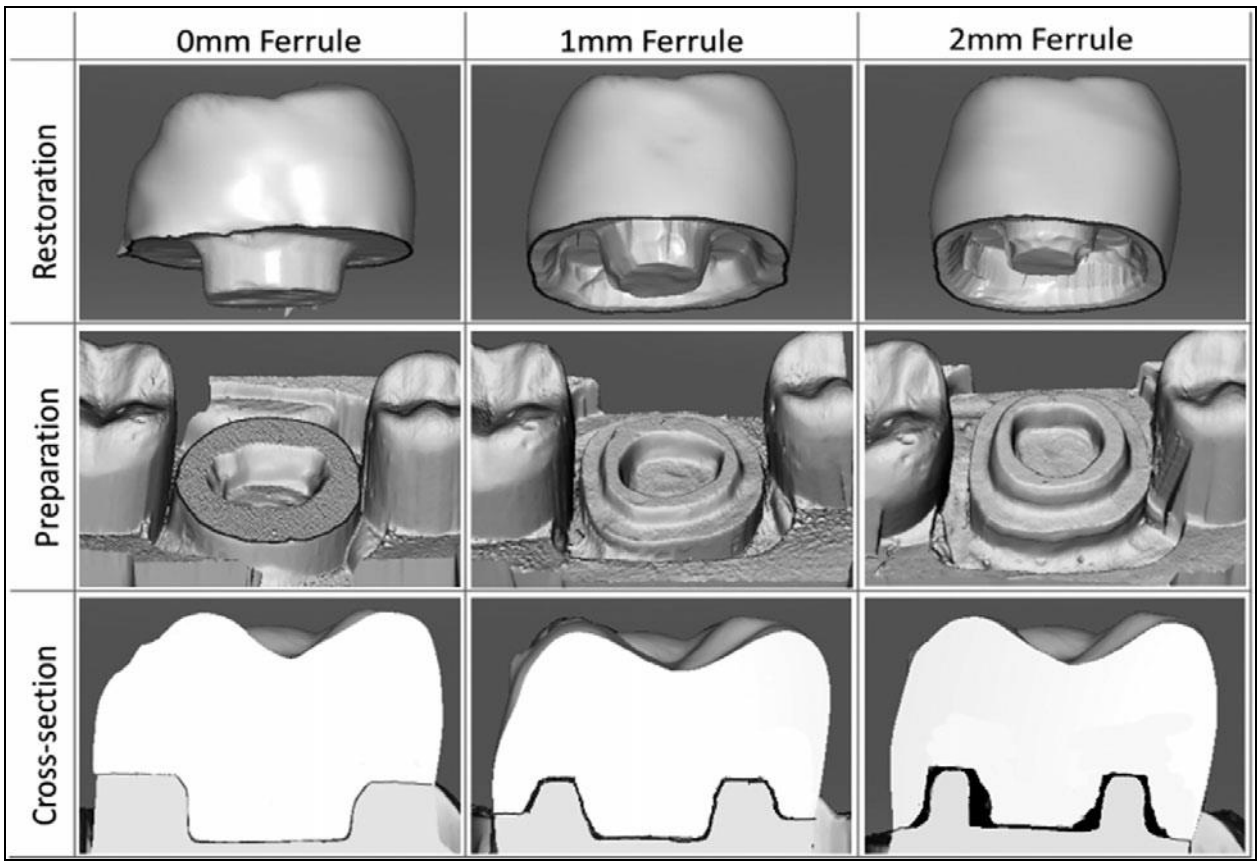


**Fig 1:** Three preparation design with no ferrule, 1 mm ferrule, 2 mm ferrule. Reproduced with permission from *Einhorn M, DuVall N,* Wajdowicz M, Brewster J, Roberts H. Preparation Ferrule Design Effect on Endocrown Failure Resistance. Journal of Prosthodontics. 2019; 28(1):e237-42. (John Wiley and Sons Publication)

**Conclusion**

Endocrown is now considered to be a highly recommended restorative option for restoring endodontically treated teeth. It is preservative to the tooth structure and has several mechanical and aesthetic advantages. It's indicated in posterior teeth and showed better performance in molars than premolars. The preparation is minimally invasive in comparison to post-core and crown and should provide sufficient retention and stability and structural durability to the restoration. More in-vitro studies need to be conducted, testing the alternative and innovative features in the endocrown tooth preparation to further improve the retention and durability of the restoration in premolars and anterior teeth.

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**Conflicts of interest**

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial, in this article.

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