**REVIEW ARTICLE**

**Endocrown Restorations: A Review**

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**Abstract:** Rehabilitation of endodontically treated teeth with large coronal destruction is still a clinical challenge, especially due to the loss of strength characteristics associated with the removal of pulp and surrounding dentin tissues. The most commonly used restoration for these teeth involves a post retained foundation restoration and a crown. Despite all clinical success achieved with the use of intra-radicular posts, one disadvantage of this system is the additional removal of sound tissue needed for fitting the post into the root canal. Additionally, this procedure affects the overall biomechanical behavior of the restored teeth. With the advent of adhesive dentistry and increasing emphasis on minimally invasive principles, new therapeutic options have been developed for the restoration of endodontically treated teeth, particularly endocrowns. Compared to conventional methods, good aesthetics, better mechanical performance, and less cost and clinic time are the advantages of endocrowns.

**Keywords:** endocrown, adhesive restoration, endodontically treated teeth.

**Introduction**

Endodontically treated teeth have an increased risk of biomechanical deterioration because of significant loss of tooth structure which impacts the tooth’s long-term prognosis. Since the coronal retention of the restoration is usually compromised, the most commonly used restoration for these teeth still involves a post retained foundation restoration and a crown.¹⁻⁵

The only advantage of inserting a post is to increase the retention of the core foundation. Conversely, intracanal retention weakens the tooth structure and increases the risk of root fractures. In the event of failure, in addition to exposing the tooth to irreversible fractures, the invasive nature of this type of restoration often excludes the possibility of further intervention.⁶⁻⁸ With progress in the development of adhesive techniques & increasing emphasis on minimally invasive principles, new therapeutic options have been developed for the restoration of endodontically treated teeth, particularly *Endocrowns* which are challenging the post-and crown concept. These restorations have macromechanical retention by being anchored to the internal portion of the pulp chamber and to the cavity margins and microretention by adhesive cementation.²

**Background**

First described in 1995 by Pissis, the monoblock technique was the forerunner of the endocrown. The term endocrown was first used by Bindl and Mormann in 1999. They described an adhesive monolithic ceramic restoration anchored in the pulp chamber, exploiting the micromechanical retention properties of the pulp-chamber walls. *Endocrowns* resemble the intraradicular post, the core and the crown in one component, thus representing monoblock.³ (Figure 1)

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Reasons for weakness in an endodontically treated tooth:

- The loss of structural integrity associated with caries, trauma and extensive cavity preparation leads to reduction in stiffness and fracture resistance of endodontically treated teeth.¹
- The loss of the marginal ridges reduces dental resistance by 63%. This is due to a rupture in the continuity of the peripheral circle of the tooth, which may result in microfractures since it creates a gap in the edges of the restoration.²
- An endodontically treated tooth also suffers deterioration in its neurosensory feedback system following removal of the pulp tissue which reduces it’s protection against masticatory forces.³

Risks and shortcomings in conventional post and core:²

- Procedural accidents such as strip perforations in an apical area of the lateral root surface and incidents of root fractures increases with posts placement.
- Nowadays, it is possible to bond prefabricated glass fiber-reinforced posts (GFRP) to the radicular dentin inside the root via a resin-dentin interface. However, this concept is still challenging in the clinical practice as ideal bonding inside the root canal faces many obstacles such as the tissues moisture control, the smear layer management and the adhesive volatile components removal.
- The materials used for core build ups includes amalgam, glass-ionomer materials, and composite resin have many shortcomings. The glass-ionomer materials lack adequate strength. Amalgam has many well-recognized limitations, in cases with minimal coronal tooth structure, additional pins or other methods are needed to provide retention. Amalgam can cause esthetic problems with ceramic crowns in addition to a risk of tattooing the cervical gingiva.
- Composite resins have been considered an ideal core build-up material due to its adhesive properties and compatibility with many posts. However, on the negative side, they show polymerization shrinkage leading to gap formation and subsequent microleakage.

Endocrown restorations:
The true breakthrough in the restoration of endodontically treated teeth was the introduction of adhesion, propelled by the development of effective dentin adhesives. The chief advantage of adhesive restorations is that macroretentive elements are no longer mandotary as long as enough surface is available. The adhesive technique prevents marginal leakage and reduces the penetration of microorganisms from the crown toward the apex, thus contributing to the clinical success of the endodontic treatment. By following this rationale, endocrowns are applied as a prosthetic option in restoration of endodontically treated incisors, premolars and molars with excessive tissue loss.⁴

Several clinical and in vitro studies agree that endocrowns are an excellent treatment solution with excellent survival rates and satisfactory clinical performance in the short, medium, and long term for molars restored in this way. In addition, endocrowns had fewer catastrophic failures than crowns (with or without post retained restoration), with 6% of root fractures for endocrowns and 29% for crowns. Most failures found in endocrowns were due to loosening (71%). The importance of respecting the adhesion protocol, thus ensuring the sustainability of the restoration, was stressed in several of the studies. For premolars and incisors, the number of clinical studies that focused on endocrowns remains low and more long-term prospective studies are necessary to validate the findings.¹

Moreover, the trapezoidal shape of the pulp chamber in mandibular molars and triangular shape in maxillary molars increase the restoration’s stability, and
additional preparation is not needed. This anatomy, along with the adhesive qualities of the bonding material, makes it unessential to attempt further use of post-involving root canals. In fact, the root canals do not need any specific shape; therefore, they are not fragilized by the drilling and they will not receive the stresses associated with the use of post. Hence, the compressive stresses that are received at the tooth/restoration interface are more properly dissipated along the overall restored tooth structure.5,6

**Preparation Technique for Endocrowns:**7

The main purpose for the use of endocrowns is to attain a bonded restoration that is minimally invasive of root canals. Therefore, the endocrown preparation is different from the conventional full coverage crowns. Several studies described the endocrown preparation following Bindl and Mormann technique, while few studies described some modifications to the original preparation.

**Occlusal Preparation:**

- The goal in preparation is to achieve an overall reduction in the height of the occlusal surface of at least 2 mm in the axial direction. This reduction can be achieved by drilling 2 mm deep groves as guides, then using a green diamond wheel bur to reduce the occlusal surface.
- 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. (figure 2, 3)
- Ideally, the margins should be kept supragingival all over. In areas of esthetic requirements, a slope of not more than 60° should be between the different cervical levels. Any undermined enamel with less than 2 mm thickness should be eliminated.
- The cervical sidewalk is the foundation of the restoration and the objective is to accomplish a wide, uniform, steady surface resistant to compressive stress.

**Axial Preparation:**

- The axial preparation involves eliminating undercuts in the access cavity. A cylindrical conical green diamond bur with total convergence angle of 70° is used to make the coronal pulp chamber and endodontic access cavity continuous. (figure 4)

**Figure 2:** Occlusal preparation

**Figure 3:** Preparation of cervical sidewalk

**Figure 4:** Axial preparation using a cylindro-conical drill
mm depth for molars. The thickness of the ceramic occlusal portion of endocrowns is usually 3-7 mm.

**Polishing the cervical band:**

- The bur used in this step has the same taper as one in the axial preparation but a larger diameter and a finer particle size. It should be guided around the entire cervical band to remove micro-irregularities and produce a flat polished surface. The margin line should appear as a regular margin with a sharp edge.

**Preparation of the cavity floor:**

- Gutta percha is removed to a depth not more than 2 mm to take advantage of the saddle like anatomy of the cavity floor.
- Pulp chamber is cleaned thoroughly followed by the bonding of the endocrown with the help of adhesives such as self-adhesive RelyX Unicem (3M) or other resin cements. (figure 5)

**Effects of ferrule incorporation:**

- 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.
- The consequence of the ferrule features incorporation, on molar endocrown failure resistance revealed that adding ferrule to preparations increased the dentin surface available for bonding. However, there were milling limitations in reproducing the endocrown’s inner surface.

**Impression technique:**

Either a conventional impression with rubber base impression material or a digital impression of the prepared tooth can be taken. (fig. 6)

**Manufacturing:**

Endocrown restorations can be milled by CAD/CAM technology (Computer-aided Design/Computer-aided Manufacture), which minimizes clinical adjustment procedures and the incorporation of defects during preparation, as well as allowing the treatment to be performed in a single session. The CAD-CAM system has a biogeneric option, which is a database that allows for the selection of occlusal anatomy that better adapts to the scanned preparation and antagonist anatomy, thereby eliminating the need for diagnostic waxing. (fig. 7)

**Materials used for fabrication of endocrowns:**

**Indications:**

- Excessive loss of tissue of the crown. (fig. 8)
- Interproximal space is limited and traditional rehabilitation with post and crown is not
possible because of the increased thickness of such restoration.

Figure 8: Tooth with excessive loss of coronal structure restored with endocrown

- Endocrowns are also an alternative in teeth with short or atresic clinical crowns, calcified, curved or short root canals that make post application impossible.
- An endocrown is indicated for premolars when the cementation surface area is sufficient: remains 1–2 mm of wall above the gums to enable proper cementing, when the walls are 2 mm or more thick, and when the pulp chamber is at least 3 mm deep.

Contraindications:
- If adhesion cannot be carried out, if the depth of the pulp chamber is < 3 mm,
- If the thickness of the peripheral walls is < 2 mm.
- Endocrowns are contraindicated in an unfavorable occlusal setting (parafuctions).

Advantages:
- Less mutilating procedure and is less invasive than post and core restorations because the pulp floor provides good stability in addition to the quality of the adhesive materials when conditions are met.
- Preserving the periodontium by remaining above the gum presents the advantage of facilitating the taking of an impression and of retaining a quantity of residual dental structure.

- In conventional restorations, there is a risk of perforating the root while unfilling the canal. There is no such risk with endocrowns.

<table>
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<tr>
<th>STRUCTURE</th>
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<tbody>
<tr>
<td>Feldspathic ceramic</td>
<td>VITA Mark II; VITA Zahnfabrik</td>
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<tr>
<td>Lithium disilicate reinforced glass ceramic</td>
<td>Emax CAD, Ivoclar Vivadent AG</td>
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<td>Nanofill composite</td>
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<td>Polymer infiltrated ceramic network (PICN)</td>
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<td>Zirconia reinforced lithium silicate glass ceramic</td>
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<tr>
<td>Zirconia reinforced lithium disilicate glass ceramic</td>
<td>Celtra Duo; Dentsply Sirona</td>
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- Easy to apply and require a short clinical time
- Low cost and ease of application
- Minimal chair time and
- Aesthetic properties.

Limitations
The recommended use of endocrowns for premolars requires further study, especially clinical trials, to corroborate the results reported in the in vitro studies. The lack of data on endocrowns on incisors and the varied results obtained mean that a clinical indication for restoring anterior teeth with endocrowns cannot yet be stated.

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.

References: