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ENDOCROWNS: A REVIEW ARTICLE

Endodontics

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ABSTRACT

The restoration of endodontically treated teeth presents a clinical challenge due to the significant loss of tooth structure and altered biomechanical properties. Endocrowns, which utilize the pulp chamber for retention without intraradicular posts, offer a conservative and efficient solution, particularly in posterior teeth without sufficient coronal bulk. The evidence suggests that endocrowns provide comparable or superior performance to conventional methods under appropriate conditions. The optimal restoration outcomes depend on careful case selection, material choice and adherence to proper bonding protocols. This review critically evaluates endocrowns in terms of fracture resistance, longevity, esthetics and clinical applicability.

KEYWORDS

Endocrowns; Endodontically treated teeth

1. INTRODUCTION

Restoration of endodontically treated teeth (ETT) remains a complex clinical decision due to their compromised structural integrity resulting from caries, access cavity preparation, and root canal instrumentation. ETTs may become more brittle over time and are more prone to fractures due to changes in collagen cross-linking and dehydration. [1]

Among the commonly used restorations are post and core systems, amalgacore restoration, conventional crowns, biomimetic restorations, occlusal veneers, crownlays, vonlays and endocrowns. The choice depends on several factors such as the amount of remaining tooth structure, location of the tooth, functional load, and esthetic considerations. Traditionally, conventional crowns and post and core were the choice of restoration. However, they include the risk of tooth fracture due to excessive removal of remaining tooth structure, difficulty with future endodontic retreatment, the potential for perforation during post space preparation, higher costs and repeated appointments.This led to drastically shifting to more conservative approach.[2]

Endocrowns are monolithic restorations fabricated from ceramics or resin-based materials that utilize the pulp chamber for macro-mechanical retention, without intraradicular post placement (Bindl & Mörmann, 1999). Pissis developed the technique for endocrown restoration in 1995, but the term endocrown was coined by Bindl and Mormann in 1999. [3] They described endocrowns as monolithic, single-piece restorations made of either full-composite or full-ceramic materials that partially or totally restore the coronal portion of an endodontically treated tooth. These restorations rely on macro-mechanical retention, achieved by anchoring the restoration within the pulp chamber's internal portion and to the cavity's margin. They also rely on micromechanical retention using adhesive cementation. Wide variety of materials choice is available, like feldspathic, lithium disilicate, leucite-reinforced and lithium silicate glass ceramics, zirconia, hybrid ceramics and composite resins, according to the particularities of the clinical case.[4]

2. Indications [4,5,6]

- Molars with substantial coronal destruction.
- Limited interocclusal space
- Short clinical crowns where it is difficult to apply adequate ferrule
- Curved root canals with short roots.

3. Contraindications [2,4,6,7]

- In cases where there is extensive loss of tooth structure beneath the cementoenamel junction, preventing proper adhesion, or when the pulp chamber is shallow.
- In cases of parafunctional habits that increase lateral stress, as indicated by steep occlusal anatomy, wear, or facets.

4. Advantages

- These have a precise internal and marginal adaptation, functional occlusal contacts, and pleasant esthetic appearance. [6,8]
- Conservative, minimally invasive by avoiding root canal enlargement. [9]
- Reduced working time by eliminating certain clinical and technical steps.
- Ensure even distribution of the occlusal forces that mimic the natural tooth.
- Reduced number of interfaces in the restorative system [endocrowns integrate the retention element and the crown portion into a single, monolithic piece. This eliminates the interface between a separate post and core, and the core and the crown, which are common failure points in traditional post-and-core restorations and reducing the number of interfaces, endocrowns can minimize stress concentrations at these junctions, potentially leading to better long-term performance and reduced risk of fracture or debonding]. [10, 11]
- Stress concentration is less because of the reduction in the nonhomogenous material present
- Involvement of the biological width is minimal.

5. Disadvantages [2,4]

- Debonding and risk of root fracture because of the difference in the modulus of elasticity between the ceramic and dentin.
- Technique-sensitive bonding procedures, potential for debonding, especially in premolars (due to smaller dimensions of the pulp chamber resulting in reduced bonding surface area. Also, the greater ratio of preparation to the overall crown height in premolars creates a higher leverage effect which decreases the fracture resistance, particularly in presence of non-axial forces), limited long-term data compared to post-and-core systems.[5]

6. Prepration

The preparation technique of an endocrown is different from conventional crowns. For ceramic materials, a minimum occlusal reduction of 2 mm (Fages et al) is recommended, whereas a reduction of 1-1.5 mm (Rocca and Krejc) is sufficient for composite materials. [4]

Endocrown preparations typically do not involve the use of a ferrule. However, there is an alternative design option for endocrown preparation that incorporates the ferrule effect along with a shoulder finish line. The ferrule effect refers to a collar encircling the dentin's parallel walls, extending in a 360- degree manner above the preparation's shoulder. In this design, it follows the same concept as the butt joint, but with the addition of a 90-degree shoulder margin positioned on the vertical wall. This margin has a width of 1 mm and is located in the sound enamel. Its purpose is to provide extra-short axial walls that counteract shear stress, resulting in improved marginal load

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control and better load distribution in the pulpal floor.

The preparation of the pulp chamber involves removing the undercuts in the access cavity with a 7-degree occlusal taper, which creates a continuous chamber and access cavity. The bur should be held parallel to the long access of the tooth without touching the pulp chamber to create smooth, tapered walls. Several researchers reported that increasing the pulp chamber depth did not affect fracture resistance of endocrowns.[4,12]

For cementation adhesive cements play an important role in the performance and durability of endocrown and helps to obtain micromechanical retention. Adhesion helps to distribute stress effectively, resulting in increased fracture resistance. Resin cements (conventional resin cements / self-adhesive cements/ Dual-cure cements) are commonly used for endocrown cementation because of their excellent bonding strength, aesthetic features, high mechanical properties and low solubility . [4,5]

7. Criteria for Evaluation of Endocrowns

The USPHS (United States Public Health Service) criteria, modified for endocrown evaluations, assess restorations based on factors like marginal adaptation, color match, anatomic form and patient satisfaction. These criteria are used to categorize endocrowns as clinically excellent (Alfa), acceptable (Bravo) or unacceptable (Charlie). This criteria is used to standardize the evaluation of endocrowns in clinical trials and research studies. By using these criteria, researchers can compare the performance of different materials, techniques, and designs for endocrown restorations. This helps clinicians make informed decisions about which restorations are most suitable for their patients. [6]

8. Comparative Studies

8.1 Fracture Resistance

- Various studies conducted to compare the fracture resistance and other mechanical properties showed zirconia to have highest fracture strength compared to VITA ENAMIC , IPS e. max CAD (EM) and BioHPP (BH) [Elashmawy et al (2021)]. In a similar study by Kanat et al (2018), it was found that zirconia had higher fracture resistance compared to feldspathic-ceramic (Vita Mark II-VM2), lithium-disilicate glass-ceramic (IPS e. max CAD-E. max), resin-ceramic (LAVA Ultimate-LU) and polymer infiltrated ceramic (Vita Enamic-VE). Another study conducted by Dartora et al (2020) concluded zirconia to have higher fracture resistance than leucite-based glass-ceramic and lithium disilicate-based glass-ceramics. On contrary, a study conducted by El-Damanhoury et al (2015) concluded that nanoceramics had comparable fracture resistance to feldspathic porcelain and lithium disilicate. Gresnigt et al (2016) reported that lithium disillicates on lateral loading showed higher fracture resistance.. [2,4,5,6,8,12,13]
- **Mechanical Properties:** Various studies compared the influence of different designs on the mechanical properties of endocrowns. A study compared fracture strength for three different thicknesses of endocrowns fabricated from lithium disilicate (3, 4.5, 6 mm), highest fracture strength was found in the 3 mm group. It was suggested that with the increase of crown height, the flexing of the restoration and leverage action is expected to increase upon load application, which will exert high stresses on the tooth, restoration, and toothrestoration interface.[14] Zhu et al (2020) analysed stress distribution in dentin around endocrowns under oblique load and concluded that the central retainer shape should be designed based on the anatomical form of the pulp chamber. [4,13]
- **Design Features:** When comparing the butt joint design to the shoulder design with a ferrule, the butt joint design is less complex and has superior marginal integrity and internal adaptation. However, studies of the effects of the ferrule and shoulder design have yielded conflicting results. Some researchers suggest that the shoulder design with a ferrule offers greater fracture resistance and a lower incidence of catastrophic failures compared to the butt joint design. Others have reported no significant differences in stress distribution and fracture resistance between the two designs. For optimal outcomes, it is ideal to maintain the margins supragingivally in a circumferential manner. Additionally, any undermined enamel should be remove. Also, in comparison to the post and core restorations, bonding surface offered by the pulpal chamber of the endocrown is often equal or even superior to that obtained from the bonding of a radicular post of 8 mm depth. [4,5,6,12]
- **Posterior Endocrowns vs. Post and Core:** Endocrowns demonstrate comparable or higher fracture resistance than post-and-core restorations in molars. [13,15] Porto et al. in 2016 recommended that the endocrown is similar to or better than conventional treatments, such as post-retained crowns, direct composite restorations, inlays, and onlays in molars. Govare and Contrepois also suggested that endocrowns can be used as a better alternative to post-retained restorations in molars. They also concluded that endocrowns generated lower stress levels in both the restorative material and the luting material compared to post core-crown restorations. [5,6, 16,17]
- **Anterior Endocrowns vs. Post and Core:** Endocrowns demonstrated comparable fatigue resistance under load to failure to post core-crown restorations. Endocrowns without ferrule exhibited a higher rate of debonding but had significantly more repairable failures. However, post core-crown restorations demonstrated higher fracture resistance with the presence of ferrule, but were associated with more catastrophic failure patterns. Hofsteenge and Gresnigt found no significant difference in fracture strengths between endocrowns and traditional post and core on central and lateral incisors. However, endocrown restorations had significantly more repairable failure patterns than post and core restorations in the central incisor groups. The post and core groups were accompanied by irreparable vertical root fractures, in contrast to endocrown groups that demonstrated horizontally oriented restorable fractures.[18]
- **Endocrowns vs. Onlays:** Endocrowns tend to out perform onlays in fracture resistance, especially in teeth with substantial structural loss. [16, 17] Nasr et al (2024) conducted a study to evaluate the effect of inlay, onlay and endocrown restorations on failure mode and fracture resistance in endodontically treated teeth and concluded that endocrowns have higher fracture resistance then inlays and onlays.[19, 20]

8.2 Survival and Success Rates

- Endocrowns: In a study 5-year survival rate for endocrowns was reported between 87%–95%. [9] The estimated overall 5-year success rates were 77.7% for endocrowns and 94% for conventional crowns. In another study conducted by Al-Dabbagh et al for survival rates with regard to endocrowns in an estimate of 5 years, a success rate of 91.4% was observed in comparison to 98.3% for conventional crowns. [21,22,23]

8.3 Marginal Integrity and Microleakage

- Endocrowns show good marginal integrity when bonded correctly but are sensitive to isolation during cementation [23,24].

8.4 Esthetics and Patient Satisfaction

- Ceramic endocrowns score high in esthetics due to their monolithic, translucent materials.[22,25,26]

9. Indications and Clinical Guidelines

Condition	Endocrown	Post and Core	Onlay
Extensive coronal loss	✓	✓	✗
Minimal remaining tooth structure	✓	✓	✗
Molars	✓	✓	✓
Premolars	Limited	✓	✓
Esthetic zone	Ceramic	Fiberpost preferred	✓
Limited interocclusal space	✓	✗	✓

10. CONCLUSION

Endocrowns have emerged as a viable and conservative alternative to post-and-core restorations and onlays for endodontically treated teeth, especially molars. Their performance in terms of fracture resistance, esthetics, and survival rates is comparable, if not superior, under certain conditions. However, clinical success heavily depends on case selection, bonding protocol, and operator expertise.

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