

## Endocrowns: A Review Article

Waad Alomran\*

Dental Intern, College of Dentistry, King Saud University, Riyadh, Kingdom of Saudi Arabia

### Review Article

\*Corresponding author

Waad Alomran

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**Abstract:** This article aims to provide a comprehensive literate review of endocrown restorations for the restorative dentist as they might be hesitant to apply such a successful treatment option of endodontically treated teeth in their clinical practice because it's not as widely used as other conventional fixed indirect restorations such as crowns and onlays.

**Keywords:** endodontically treated teeth, CAD/CAM, restorations, crowns, posts, endo-core.

### INTRODUCTION

The restoration of endodontically treated teeth that are grossly destructed has been a challenge for many clinicians over the years. Endodontically treated teeth exhibit various physiological alterations in the dentin composition and microstructure which predispose the tooth to multiple risk factors, such as, reduced retention/stability, increased tooth fragility, compromised substrate adhesion and eventually leading to failure of the prosthesis [1]. Further studies reported and linked the access preparation with decreased structural integrity which lead to a higher occurrence of fractures in endodontically treated teeth compared with vital teeth [2]. Studies found that endodontic access preparations resulted in increased cuspal deflection during function [3, 4]; Therefore, cuspal coverage of posterior teeth was recommended [5]. When two or more axial walls of the endodontically treated tooth are missing, a widely used two-step recommended treatment option of placing a conventional post and core followed by a full converge crown [5]. This protocol is considered time consuming and it can be reduced with a one-step procedure using endocrowns that are more practical in terms of time and costs [6, 7].

Endocrowns were first developed by Pississ in 1995 [8]. which is described as a monolithic (one-piece) full-composite or full ceramic overlays which restore partially or totally the coronal part of a devitalized tooth characterized by a supracerivical butt joint, retaining maximum enamel to improve adhesion and extended inside the pulp chamber and partially inside the root canal with a short "endo-core", could represent an alternative to classical treatments to restore endodontically treated teeth [9]. 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 [10].

### Risks and shortcomings in conventional post and cores

It has been suggested that the primary purpose of a placing a post is to retain the core in teeth with extensive loss of coronal tooth structure [11, 12]. Although rare, procedural accidents during the post space preparation occurs. These accidents could be perforation in an apical area of in the lateral root

surface, so-called "strip perforations". Also, incidents of root fractures increases with posts placemat [10]. Nowadays, there is a paradigm shift towards Bonded prefabricated glass-fiber-reinforced posts (GFRP) due to esthetic its translucency and esthetic properties, a similar modulus of elasticity to the dentinal tissue and the possibility to bond these posts 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 is faced with many obstacles such as the tissues moisture control, the smear layer management and the adhesive volatile components removal. Besides the degradation of the resin-dentin interface with the time. Moreover, the surface geometry due to the anatomy of the canal offers an extremely unfavorable relief of the shrinkage stresses developed by the polymerization of the resin cement. The C-factor (bonded/unbonded surfaces ratio) in the long and narrow root canal hinders any resin flow during hardening [9].

As the post retains the core, the core in turn will retain the crown. 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 [13, 14]. Amalgam has many well-recognized limitations, in cases with minimal coronal tooth structure, additional pins or other methods are needed to provide retention. Also, crown preparation must be delayed to permit the material to set. Amalgam can cause esthetic problems with ceramic crowns in addition to a risk of tattooing the cervical gingiva [15]. Currently, Composite resins became the most popular and have been considered an ideal core build-up material due to its adhesive properties and compatibility with many posts [16]. In addition to, it's high tensile strength, immediate tooth preparation after polymerization, and esthetic properties [17]. However, on the negative side, composite resins shrink during polymerization shrinkage leading to gap formation and subsequent microleakage. Also, after polymerization it will absorb water causing it to swell [18]. It undergoes plastic deformation under repetitive loads [19, 20]. Adhesion to dentin on the pulpal floor is generally not as strong or reliable as to coronal dentin [21]. Strict isolation is needed to prevent contamination with blood or saliva during the bonding procedure which will greatly compromise the bond strength [5].

#### **Premolars restored with endocrowns**

There is a lack of data about the influence of the endocrown design on the biomechanical behavior of restored endodontically treated premolars (ETPM). Bindl *et al.*, considered that endocrowns are unsuitable restorative approach for premolars with a failure rate of 31% while molars restored with endocrowns had 12% failure rate. This difference in the failure rates is attributed to decreased surface area available for adhesion in premolars in addition to the unfavorable ratio between crown basis and crown height might cause a moment of force [22]. Even though it was suggested by Pissis that endocrowns preparations must be of 5mm depth [8]. As It seems reasonable to hypothesize that the deeper the pulp-cavity preparation for an endocrown and the deeper the resultant intra-radicular extension "endo-core", the greater the surface area for adhesive retention and the better the transmission of masticatory forces to the root [23]. Pedrollo Lise *et al.*, tested the biomechanical behavior of endodontically treated premolars using different preparation designs and CAD/CAM materials. 48 teeth were divided into six groups. Each group were restored using one of the two tested materials with standardized CAD/CAM fabricated endocrowns (with either 2.5mm or 5mm deep intra-radicular extension) or conventional crowns (5-mm deep post and crown). In the '2.5-mm deep endo-core' groups, the composite resin endocrowns achieved a significantly higher load-to-failure than the lithium disilicate glass-ceramic, while no differences between materials were found in the '5mm deep endocrown' and '5mm deep post and crown' groups [7].

#### **Mechanical properties of Endocrowns**

In a study that compared the fracture strength of endocrowns and glass fiber post retained conventional crowns, the results showed significantly higher fracture strength for endocrowns 674.75 N when compared with conventional crowns 469.90 N. The failure pattern was characterized by fracture of the tooth associated with displacement of the restoration on the opposite side [24]. Rocca *et al.*, performed fracture analysis using both stereomicroscope and Scanning Electron Microscopy (SEM) on endocrowns with 2mm and 4mm extension of the core within the pulp chambers below the ECJ and conventional crowns with a 5mm post and 3.5mm core. All restorations experienced non-reparable fractures. Though, different fracture paths were observe. Endocrowns fractured mesio-distal vertical fracture which split the restoration "wedge-opening fractures". In contrast, the conventional crown with post and core group displayed catastrophic fractures in multiple pieces. Fractographic analysis revealed that in all fractured restorations the origin of the fracture was always at the occlusal surface, mainly from the major contact loading and propagated coronally [9].

In a recent study published in 2018, reported that upper premolars restored with endocrowns with both 2mm and 4mm long endo-cores displayed similar outcomes in terms of marginal integrity and fatigue resistance equivalent to classical crowns and did not seem to have an influence on endocrowns performances. However, it concluded that further studies are needed to confirm this hypothesis [9]. Lin *et al.*, reported that there was a significant difference of the stress values at the luting cement interface between the endocrown (2 MPa) and the classical crown (15.36 MPa). This indicates that the stress concentration within the cement occurred at the central groove area of the occlusal surface in the classical crown configuration. Hence, the reduced effect of multiple interfaces in the restorative system of the endocrown configuration might make the restored tooth more approximate to a "monobloc" and thereby reduce adhesive interface failure. Also, they concluded that failure probability and fatigue-load testing revealed that the endocrown and the classical crown obtained nearly the same performance and endocrowns can be considered as a feasible, conservative, and aesthetic restorative approach [25]. In 2016, A systematic review and meta-analysis of endocrowns restorations was published. In this systematic review endocrowns presented high clinical success rates (94 to 100% up to 36 months). Furthermore, the reason of failure was secondary caries, and no study reported fracture or retention loss of endocrown. However, they advised that the results should be interpreted with caution as the interrupted studies advocated small sample sizes and high risk of bias and further studies and especially clinical trials with long follow-up periods are of utmost importance to

clarify the usage of endocrown restorations for rehabilitation of severely compromised, endodontically treated teeth [26].

#### Contraindications of endocrowns

Endocrowns can't be used in the following scenarios: (1) less than 3mm pulp chamber depth. (2) When adhesion cannot be assured. (3) If only negligible remaining tooth structure is present [27].

#### CAD/CAM endocrowns

In a systematic review of the clinical performance of CAD/CAM single-tooth restorations that included 16 articles with the total of 1,957 restorations included 48% that were prospectively analyzed and 52% that were studied retrospectively. The majority of the studied restorations were on posterior teeth 98% and only 2% were on anterior teeth in which none of the analyzed studies reflected an RCT protocol design. This systemic review reported that endocrowns had a significantly higher failure rate than all other investigated restorations with an estimated failure rate of 3.9% per year, estimated per 100 restoration years and the lowest 5-year survival rate was found for endocrowns (82.3%) P value= 0.026. In contrast to conventional crowns the estimated 5-year survival rate was 92.3%. Other findings of this systemic review were: There is no significant differences between the failure rates of the different CAD/CAM systems. In regards to the material choice glass-ceramic restorations had a significantly higher failure rate than all other materials (P < .001, 18.18%) and ceramics with aluminum and magnesium oxide (In-Ceram Spinell) had the highest survival rate 96.8%. The luting cements did not appear to affect the outcome of the mentioned study. Also it concluded that the long-term survival rates for CAD/CAM technology– fabricated single-tooth restorations demonstrated clinically similar outcomes to conventionally manufactured restorations [28]. Moreover, a study evaluated the marginal and internal discrepancies of endocrowns with different cavity depths 2mm and 4mm fabricated using two different chairside CAD-CAM systems (CEREC AC and E4D) concluded that marginal and internal discrepancies increased depending on cavity depth and both chairside CAD-CAM systems showed similar discrepancy in the endocrowns [29]. In contrast, another study, that used lithium disilicate CAD-CAM ceramics to fabrication conventional crowns and endocrowns stated that the differences in the survival between the groups were not statistically significant after the application of thermo-mechanical fatigue loading [9].

#### CONCLUSION

When it comes to survival rate and mechanical properties, endocrown restorations showed comparable or somewhat superior results to other conventional treatments using post and core followed by a crown or inlay/onlay restorations. Endocrowns are more practical, conservative, and less technique sensitive.

However, further randomized clinical trials with long-term follow up periods are recommended.

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