

ENDOCROWNS - CONTEMPORARY APPROACH FOR RESTORATION OF ENDODONTICALLY TREATED TEETH – REVIEW ARTICLE

ЕНДОКОРОНКИ - СОВРЕМЕН ПРИСТАП ЗА РЕСТАВРАЦИЈА НА ЕНДОДОНТСКИ ТРЕТИРАНИ ЗАБИ: РЕВИЈАЛЕН ТРУД

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Abstract

Introduction: Restoration of the severely destructed endodontically treated teeth remains a challenge in everyday dental practice. The development of the modern adhesive dentistry enables a minimally invasive approach in restoring severely damaged teeth. Endocrowns are minimally invasive restorations that rely on macro-mechanical retention, achieved by anchoring the restoration within the pulp chambers' walls and to the cavity's margins, and micromechanical retention, achieved by adhesive cementation. **Material and method:** A comprehensive literature search was conducted using electronic databases, including PubMed, Scopus, Web of Science and Google Scholar. Articles published between 1995-2025 were considered to ensure the inclusion of both foundational and recent advancements in the field of endocrowns. In total, 48 articles were evaluated and all useful information was incorporated into this review article. **Results:** According to literature data, the most common indication for endocrown fabrication is severely damaged endodontically treated mandibular molars. Lithium disilicate ceramic is the most commonly used material, providing acceptable mechanical and aesthetic properties, as well as the ability for adhesive cementation. In general, endocrowns have a decay-oriented preparation design concept. There are a few important aspects to consider in endocrown preparation: occlusal walls preparation, axial walls preparation and ferrule effect and pulp chamber walls preparation. Resin cements are widely used for endocrown cementation due to their strong bonding ability, aesthetics, high mechanical properties and low solubility. **Conclusion:** Endocrowns represent minimally invasive prosthetic restorations and constitute an optimal therapeutic choice for the reconstruction of severely damaged endodontically treated teeth. **Key words:** endocrowns, endodontically treated teeth restorations, minimally invasive restorations, adhesive dentistry.

Апстракт

Вовед: Реставрација на силно деструирани ендодонтски третирани заби останува предизвик во секојдневната стоматолошка пракса. Развојот на современите техники во адхезивната стоматологија овозможува минимално инвазивен пристап при оваа постапка. Ендокоронките се минимално инвазивни реставрации што се темелат на макромеханичка ретенција постигната по пат на анкерирање за сидовите на пулпината комора и маргините на препарационите кавитети и микромеханичка ретенција постигната по пат на адхезивно цементирање. **Материјал и метод:** Опсежно литературно пребарување беше спроведено користејќи ги електронските бази на податоци вклучувајќи ги PubMed, Scopus, Web of Science и Google Scholar. Со цел обезбедување инклузивност на темелите но и современите достигнувања во полето на ендокоронките, во ревијалниот труд беа вклучени клучните информации од 48 трудови објавени во периодот помеѓу 1995-2025 година. **Резултати:** Според литературните податоци, најчестата индикација за изработка на ендокоронки се силно деструирани и ендодонтски третирани мандибуларни молари. Литиум дисиликатната керамика е најчесто користен материјал кој обезбедува прифатливи механички и естетски особини како и можност за адхезивно цементирање. Препарацијата за ендокоронките е насочена кон формирање на кавитет со минимално инвазивен пристап. Постојат неколку важни аспекти во однос на препарација за ендокоронките: препарација на оклузалните сидови, обезбедување ferrule ефект и препарација на сидовите на пулпината комора. Композитните цемента се најчесто користени за цементирање на ендокоронките поради нивната силна адхезивна моќ, естетика, ниска солубилност и високи механички особини. **Заклучок:** Ендокоронките претставуваат минимално инвазивни протетски реставрации и оптимален терапевтски избор за реставрација на силно деструирани ендодонтски третирани заби. **Клучни зборови:** Ендокоронки, ендодонтски третирани заби, минимално инвазивни реставрации, адхезивна стоматологија.

Introduction

Restoration of the severely destructed endodontically treated teeth remains a challenge in everyday practice. After the root canal treatment (RCT), the tooth structures become weakened and susceptible to fractures due to the dehydration and excessive loss of dentin. Because of the considerable amount of hard tissue loss and complex microstructure modifications of the dentin, the mechanical properties and longevity of the endodontically treated teeth may be severely compromised¹.

The most common and widely accepted conventional approach for restoring extensively damaged endodontically treated teeth is to regain support for the final crown by postextension in the canal and a core build up².

Post and core is a well-established technique to restore endodontically treated teeth with significant coronal structural loss³. Metal and ceramic posts both have an elastic modulus that is much higher than that of the dentin, which could ultimately lead to root fracture when the tooth is overloaded. Fiber posts have been recommended for a more conservative approach, as their modulus of elasticity resembles that of natural dental tissues, and the utilization of adhesive luting agents ensures a more uniform distribution of occlusal stresses along the tooth structure⁴.

However, the primary role of the fiber-reinforced posts and traditional metal posts is to provide mechanical retention of the core buildup, not to increase the fracture resistance of the endodontically treated roots⁵. Keeping that in mind, a major limitation of the conventional method of restoration is the supplementary removal of the dental structure, particularly from the walls of the root canal walls, which causes a further decrease in mechanical resistance; increases the risk of root perforation during canal preparation; and creates uneven stress distribution due to differences in elastic modulus between the tooth structure and restorative materials⁶.

The development of the modern adhesive dentistry enables the minimally invasive approach in restoring severely damaged teeth, aimed at preserving a greater amount of healthy dental tissue. As a result, the necessity of using posts for mechanical retention in full-coverage crowns has been reconsidered. Endocrowns represent monolithic, conservative restorations introduced as an alternative to the conventional prosthodontic approach for severely compromised endodontically treated teeth⁷. Pissis developed the technique for endocrown restoration in 1995, but the term endocrown was coined by Bindl and Mormann in 1999. 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 macromechanical retention, achieved by anchoring the restoration within the pulp chambers' walls and to the cavity's margins and micromechanical retention, achieved through adhesive cementation⁸.

The adhesive cementation technique used in endocrowns prevents marginal leakage and minimizes the penetration of microorganisms from the crown toward the root canals, thereby contributing to the success of the endodontic treatment⁹. Despite numerous advantages offered by endocrowns, there has been still an extensive debate in literature about the optimal approach for restoring the severely damaged teeth. Therefore, this review aims to offer a more comprehensive overview of endocrowns and assesses the influence of different materials and preparation designs on the mechanical properties, survival, and clinical success, as well as to compare conventional and modern approach for restoring endodontically treated teeth.

Material and method

A comprehensive literature search was conducted using electronic databases, including PubMed, Scopus, Web of Science and Google Scholar. Articles published between 1995-2025 were considered to ensure the inclusion of both foundational and recent advancements in the field of post-endodontic restoration. The following keywords were applied: "endocrown"; "monolithic restoration"; "restorations for endodontically treated teeth".

Studies were selected based on the following criteria:

► Inclusion Criteria:

- Peer-reviewed articles published in English.
- Studies evaluating the clinical performance, biomechanical properties, longevity, material selection, and adhesive techniques of endocrowns.
- In vitro, in vivo, and clinical studies focusing on endodontically treated posterior teeth restored with endocrowns.

► Exclusion Criteria:

- Studies focusing solely on conventional crowns, post-and-core restorations, or non-endodontically treated teeth.
- Case reports, commentaries, editorials, or articles lacking sufficient methodological details.
- Duplicate studies or those with limited relevance to endocrown restorations.

Data Extraction and Analysis

Key information was extracted, including study design, sample size, type of teeth restored, restorative materials

used (e.g., lithium disilicate ceramic, zirconia, composite), adhesive strategies, and clinical outcomes such as survival rates, failure modes, and marginal adaptation. The selected studies were categorized based on common research themes, including:

- Material properties and selection criteria for endocrowns
- Bonding techniques and adhesive protocols
- Biomechanical behavior and fracture resistance
- Long-term clinical performance and failure analysis

A comparative analysis was performed to identify trends, advantages, limitations, and gaps in the existing research, highlighting areas for future investigation.

Quality Assessment

To ensure methodological rigor, selected studies were assessed based on sample size, study design, statistical analysis, and potential biases. Systematic review guidelines, such as PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), were followed where applicable (Table 1).

Table 1. Article categorization

In vitro studies
1. Chang C-Y, Kuo J-S, Lin Y-S, Chang Y-H. Fracture resistance and failure modes of CEREC endocrowns and conventional post and coresupported CEREC crowns. <i>J Dent Sci.</i> 2009;4(3):110-117.
2. Al-Wahadni A, Gutteridge DL. An in vitro investigation into the effects of retained coronal dentine on the strength of a tooth restored with a cemented post and partial core restoration. <i>Int Endod J.</i> 2002;35:913-918.
3. Atash R, Arab M, Duterme H, et al. Comparison of resistance to fracture between three types of permanent restorations subjected to shear force: An in vitro study. <i>J Indian Prosthodont Soc</i> 2017;17(3):239-249.
4. Sağlam G, Cengiz S, Karacaer Ö: Marginal adaptation and fracture strength of endocrowns manufactured with different restorative materials: SEM and mechanical evaluation. <i>Microsc Res Tech.</i> 2021, 84:284-90.
5. Gresnigt MM, Özcan M, van den Houten ML, Schipper L, Cune MS. Fracture strength, failure type and Weibull characteristics of lithium disilicate and multiphase resin composite endocrowns under axial and lateral forces. <i>Dent Mater.</i> 2016;32(5):607-614.
6. ElHamid ARA, Masoud GI, Younes AA: Assessment of fracture resistance, marginal and internal adaptation of endocrown using two different heat-press ceramic materials: an in-vitro study. <i>Tanta Dent J.</i> 2023,20:196-202.
7. El Ghouli W, Özcan M, Silwadi M, Salameh Z: Fracture resistance and failure modes of endocrowns manufactured with different CAD/CAM materials under axial and lateral loading. <i>J Esthet Restor Dent.</i> 2019, 31:378-87.
8. Sahebi M, Ghodsi S, Berahman P, Amini A, Zeighami S: Comparison of retention and fracture load of endocrowns made from zirconia and zirconium lithium silicate after aging: an in vitro study. <i>BMC Oral Health.</i> 2022, 22:41.
9. Soliman M, Alzahrani G, Alabdualataif F, et al.: Impact of ceramic material and preparation design on marginal fit of endocrown restorations. <i>Materials.</i> 2022, 15-5592.
10. Dartora NR, Maurício Moris IC, Poole SF, Bacchi A, Sousa Neto MD, Silva-Sousa YT, et al. Mechanical behavior of endocrowns fabricated with different CAD-CAM ceramic systems. <i>J Prosthet Dent.</i> 2021;125:117-125.
11. Taha D, Spintzyk S, Sabet A, Wahsh M, Salah T. Assessment of marginal adaptation and fracture resistance of endocrown restorations utilizing different machinable blocks subjected to thermomechanical aging. <i>J Esthet Restor Dent.</i> 2018;30:319-328.
12. Bankoğlu Güngör M, Turhan Bal B, Yilmaz H, Aydin C, Karakoca Nemli S. Fracture strength of CAD/CAM fabricated lithium disilicate and resin nano ceramic restorations used for endodontically treated teeth. <i>Dent Mater J.</i> 2017;36:135-141.

13. He J, Zheng Z, Wu M, Zheng C, Zeng Y, Yan W. Influence of restorative material and cement on the stress distribution of endocrowns: 3D finite element analysis. *BMC Oral Health*. 2021, 21:495
14. Adel S, Abo-Madina MM, Abo-El Farag SA. Fracture strength of hybrid ceramic endocrown restoration with different preparation depths and designs. *IOSR J Dent Med Sci*. 2019, 18:17-23.
15. AL-Zomur S, Abo-Madina M, Hassouna M. Influence of different marginal preparation designs and materials on the marginal integrity and internal adaptation of endocrown restorations. *Egypt Dental J*. 2021, 67:3491- 500.
16. Einhorn M, DuVall N, Wajdowicz M, et al. Preparation ferrule design effect on endocrown failure resistance. *J Prosthodont* 2019, 28(1):e237–e242.
17. Alqarni H, Qadoumi M, AlShehri N, AlNowaiser N, Alaqeely R, AlHelal AA, Alrabiah M, Alshihri A, Alsayed H. Resistance of Resin-Bonded Ceramic Endocrowns of Different Intracoronal Depths. *Oral Health Prev Dent*. 2025 Jan 22;23:51-58.
18. Emam ZN, Elsayed SM, Abu-Nawareg M. Retention of different all ceramic endocrown materials cemented with two different adhesive techniques. *Eur Rev Med Pharmacol Sci*. 2023, 27:2232-40.

In vivo studies

1. Balkenhol, M.; Wöstmann, B.; Rein, C.; Ferger, P. Survival time of cast post and cores: A 10-year retrospective study. *J. Dent*. 2007, 35, 50–58.
2. P. Zoidis, E. Bakiri, and G. Polyzois, "Using modified polyetheretherketone (PEEK) as an alternative material for endocrown restorations: a short-term clinical report," *The Journal of Prosthetic Dentistry* 2017;117(3):335–339.

Reviews and systematic reviews

1. Goracci, C.; Ferrari, M. Current perspectives on post systems: A literature review. *Aust. Dent. J*. 2011, 56, 77–83.
2. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature, Part II (Evaluation of fatigue behavior, interfaces, and in vivo studies). *Quintessence Int*. 2008;39:117-129.
3. D. Preethi, N. Gopi Chander, J Ramesh Reddy, P. Shanmuga priya, Aashmika Mahajan, K. S. Vigneshwaran. Endocrowns- a narrative review. *Journal of Pharmaceutical Negative Results* 2022, 3018-3025.
4. AlDabeeb DS, Alakeel NS, Al Jfshar RM, Alkhalid TK. Endocrowns: Indications, Preparation Techniques, and Material Selection. *Cureus*. 2023;15(12):e49947.
5. Govare N, Contrepolis M: Endocrowns: a systematic review. *J Prosthet Dent*. 2020, 123:411-8.e9.
6. Biacchi GR, Mello B, Basting RT. The endocrown: an alternative approach for restoring extensively damaged molars. *J Esthet Restor Dent* 2013;25(6):383–390.
7. Fages M, Bannasar B. The endocrown: a different type of all-ceramic reconstruction for molars. *J Can Dent Assoc* 2013;79:d140.
8. R. Menezes-Silva, C. A. V. Espinoza, M. T. Atta, M. F. L. Navarro, S. K. Ishikiriama, and R. F. L. Mondelli, "Endocrown: a conservative approach," *Brazilian Dental Science* 2016; 19(2).
9. Sevimli G, Cengiz S, Oruc MS: Endocrowns: review. *J Istanbul Univ Fac Dent*. 2015, 49:57.
10. Sedrez-Porto JA, Rosa WL, da Silva AF, et al. Endocrown restorations: a systematic review and meta-analysis. *J Dent* 2016;52:8–14.

11. Ciobanu P, Manziuc MM, Buduru SD, Dudea D: Endocrowns - a literature review. *Med Pharm Rep.* 2023;96:358-67.
12. Conrad H, Seong W, Pesun I : Current ceramic materials and systems with clinical recommendations: a systematic review. *J Prosthetic Dentistry.* 2007, 98:389-404.
13. Thomas RM, Kelly A, Tagiyeva N, Kanagasingam S: Comparing endocrown restorations on permanent molars and premolars: a systematic review and meta-analysis. *Br Dent J.* 2020, 1-9.
14. Rocca GT, Krejci I. Crown and post-free adhesive restorations for endodontically treated posterior teeth: from direct composite to endocrowns. *Eur J Esthet Dent* 2013;8(2):156–179.
15. Bhalla VK, Chockattu SJ, Srivastava S. Decision making and restorative planning for adhesively restoring endodontically treated teeth: an update. *Saudi Endodont J.* 2020, 10:1816.
16. Singh A, Abrol K, Agarwal S. Endocrown restorations: a review. *Chron Dental Res.* 2016, 8:21-6.
17. Papalexopoulos D, Samartzi TK, Sarafianou A: A thorough analysis of the endocrown restoration

Finite element analysis

1. Zhu J, Rong Q, Wang X, et al. Influence of remaining tooth structure and restorative material type on stress distribution in endodontically treated maxillary premolars: a finite element analysis. *J Prosthet Dent* 2017;117(5):646–655.
2. Tribst JPM, Dal Piva AMO, Madruga CFL, et al. Endocrown restorations: Influence of dental remnant and restorative material on stress distribution. *Dent Mater.* 2018;34(10):1466-1473.
3. Dejak B, Młotkowski A. A comparison of mvM stress of inlays, onlays and endocrowns made from various materials and their bonding with molars in a computer simulation of mastication - FEA. *Dent Mater.* 2020;36:854-864.
4. Lin J, Lin Z, Zheng Z. Effect of different restorative crown design and materials on stress distribution in endodontically treated molars: a finite element analysis study. *BMC Oral Health.* 2020;20:226.

Discussion

After evaluating the published articles, it was obvious that the majority of the studies were *in vitro* studies compared to only a few *in vivo* clinical studies. The primary focus of the studies was determination on the correlation between the different restorative materials used for fabrication of the endocrowns and the fracture resistance, the influence of the preparation design and the fracture resistance, as well as the advantages and disadvantages of the endocrowns compared to post and core restorations.

Indications and contraindications

Endocrowns are indicated in clinical cases when there is excessive coronal tooth structure loss and limited interocclusal space, which prevents achieving adequate ceramic thickness over the metal or the composite core¹⁰. According to the literature data, the most common indication for endocrown restorations is severely damaged mandibular molars. The classical approach for the

restoration of an endodontically treated molar with a post and core involves widening of the anatomically complex canal system, which in these teeth is often narrow, sometimes curved, and variable in angulation; such a restoration results in a 58.3% loss of tooth structure¹¹.

Endocrowns may be the solution to limitations regarding the use of intra-radicular posts, such as short or curved roots, calcified or narrow root canals and also fractured instruments in the root canals¹². Preexisting conditions for endocrown planning include: supragingival walls of 1 to 2 mm height and at least 2 mm thickness, and a pulp chamber of at least 3 mm depth¹². Also important is the presence of intact cervical enamel so that adhesive procedures can be more effective¹³.

Endocrowns are indicated for all molars, particularly those with clinically short crowns, calcified root canals, or narrow canals¹⁴. They are not recommended if adhesion cannot be assured, if the pulpal chamber depth is less than 3 mm deep, or if the cervical margin width less than 2 mm wide for most of its circumference¹². Furthermore, endocrown restoration is indicated for cases where it is

difficult to achieve an adequate ferrule, such as in teeth with short clinical crowns and extensive destruction of the tooth structure¹⁵.

Endocrowns have been proven as effective in molar restorations, but there is ongoing debate regarding their use in premolars and anterior teeth⁷. In premolars, several researchers have reported a higher failure rate for endocrowns compared to molars⁹. This is attributed to the smaller pulp chamber dimensions, resulting in a reduced bonding surface area¹⁵. Additionally, the greater ratio of preparation-to- the overall crown-height in premolars creates a greater leverage effect, which decreases fracture resistance, particularly under non-axial forces¹⁵.

In case of severe dental tissue loss, where after preparation the endcrown finish line is completely below the cementenamel junction, the use of an endcrown may not be appropriate due to the increased risk of tooth fracture and the decreased restoration retention. Hence, in this case, restoring the endodontically treated tooth using the conventional method would be more appropriate¹³.

Furthermore, when there is evidence of increased functional and lateral stresses, as seen in steep occlusal anatomy, wear facets, or parafunction, a full-coverage crown with or without post is the treatment of choice¹⁶. Similarly to premolars, incisors and canines receive higher non-axial forces compared to the more axially oriented forces on posterior teeth, which explains the limited number of studies conducted on this group of teeth¹⁷.

Materials

Several materials, such as lithium disilicate glass-ceramic, zirconia-reinforced lithium silicate glass-ceramic, zirconia, and resin composites, have been used to fabricate endocrowns¹⁸.

The choice of material can impact the mechanical properties and the performance of the endcrown¹⁹.

It has been shown that endocrowns made of lithium disilicate-based ceramics are considered among the most commonly used restorative materials because of their adhesive properties²⁰.

An *in vitro* study conducted by Gresnigt et al. evaluated the effect of axial and lateral forces on the strength of endocrowns made of lithium disilicate glass ceramic and multiphase resin composite.

It has been concluded that under axial loading, both lithium disilicate glass ceramic and multiphase resin composite used as endcrown materials presented similar fracture strength, but under lateral forces, the latter exhibited significantly lower results²⁰.

In 2018, Tribst et al. evaluated the influence of restorative material type on the biomechanical behavior of endcrown restorations and concluded that leucite

ceramic presents a better stress distribution and can be a promising alternative to lithium disilicate ceramic for the manufacturing of endocrown restorations²¹.

Resin composite materials have been introduced for endcrown fabrication as an alternative to ceramic materials, primarily because of their low elastic modulus, which is similar to dentin¹⁹.

This characteristic enables appropriate stress distribution, resulting in more favorable modes of failure²².

Additionally, unlike ceramics, resin composites can be adjusted and repaired intraorally²³.

Furthermore, some researchers have reported that resin composites exhibit the highest fracture resistance compared to other materials¹⁸.

However, it is worth noting that these materials tend to have a higher degree of marginal leakage. Zoidis et al. proposed polyetheretherketone (PEEK) as an alternative framework material for endcrown restorations. They demonstrated that the elastic modulus of the polyetheretherketone framework (4 GPa) veneered with indirect composite resin, could absorb the occlusal forces, protecting tooth structures better than ceramic materials, but further long-term clinical evidence is required²⁴.

Zirconia-reinforced lithium silicate glass-ceramic is a glass-based ceramic material that incorporates zirconia particles into its matrix to enhance its mechanical and physical properties²⁵.

However, although the addition of zirconia particles increases the material's strength and resistance to deformation, it also reduces the bond strength between the restoration and tooth structure.

Additionally, the high modulus of elasticity of this material leads to stress concentration at the weakest points, potentially leading to catastrophic tooth failure²⁶.

Zirconia, a polycrystalline ceramic material devoid of a glass phase, is widely used because of its excellent mechanical properties²⁷.

However, zirconia lacks the ability to be etched using routine methods, which can result in reduced bond strength and potential restoration debonding²⁸.

Furthermore, it has exhibited the highest rate of catastrophic failures compared with other materials²⁷.

Dejak et al. reported that zirconia endocrowns exhibited the highest fracture strength in a finite element analysis of stress distribution²⁹.

Also, zirconia was shown to have a higher stress concentration than lithium disilicate ceramic restorations regardless of the occlusal thickness of the endcrown in finite element analysis evaluating stress distribution³⁰.

However, in their studies, Dartora et al. concluded that despite their increased fracture resistance, monolithic zirconia endocrowns also presented the highest nonrestorable failure patterns³¹.

Taha et al. compared fracture strength of resin nanoceramic endocrowns with lithium disilicate, polymer-infiltrated ceramic, and zirconia-reinforced lithium disilicate endocrowns in mandibular molars and found that the resin nanoceramic and lithium disilicate groups showed the highest fracture strength³².

In another study, El Ghouli et al. found that lithium disilicate endocrowns exhibited higher fracture strength when compared to zirconia-reinforced lithium disilicate ceramic and resin nanoceramic for both endocrowns and crowns²⁶.

Also, Güngör et al. when comparing resin nanoceramic and lithium disilicate endocrowns and crowns, found that lithium disilicate endocrowns had the highest fracture strength³³.

According to Zheng et al., resin composite may also represent an effective alternative for endocrowns compared to lithium disilicate, polymer infiltrated ceramic, resin nanoceramic, zirconia-reinforced glass ceramic and hybrid nanoceramic, as it showed a more uniform stress distribution and higher fracture resistance³⁴.

Preparation designs

The primary goal of endocrown preparation is to preserve as much sound dental tissue as possible.

With respect to the endocrown length, a design that utilizes only the pulp chamber-without extension into the root canal-provides superior stress distribution compared to designs involving intraradicular extensions¹⁸.

In general, endocrowns follow a decay-oriented preparation design concept¹⁰.

Several key aspects must be considered in endocrown preparation, including the preparation of the occlusal walls, preparation of axial walls, the ferrule effect, and the configuration of the pulp chamber walls.

Endocrown restorations achieve macromechanical retention through anchorage to the pulp chamber walls and cavity margins.

The amount of occlusal reduction depends primarily on the selected restorative material. Rocca and Krejci recommended an occlusal reduction of 1–1.5 mm when resin composite is selected, taking advantage of the material's elastic modulus and stress-absorbing properties, which are similar to dentin³⁵.

Conversely, Fages et al. suggested at least 2 mm of occlusal reduction when monolithic ceramic materials are used¹².

The overall thickness of the ceramic restoration, measured from the axial wall margin to the highest occlusal point, typically ranges between 3 and 7 mm, with several studies reporting increased fracture resistance associated with greater thickness^{15,36,17}.

A butt-joint margin refers to a 90° circumferential band, 1–2 mm wide, located between the pulp chamber and the

axial walls of the tooth. It is formed during cuspal reduction and serves to enhance adhesive bonding while providing a stable surface capable of withstanding compressive forces³⁷.

Endocrown preparations typically exclude the use of a ferrule¹⁷.

However, an alternative design has been proposed that incorporates a ferrule effect along with a shoulder finish line^{7,38,39}.

The ferrule effect refers to a 360° encircling collar along the axial walls above the preparation's shoulder finish line³⁶.

In this design, a 90° shoulder margin, 1 mm wide and located in sound enamel, is added to the butt-joint configuration³⁹.

This modification aims to create short axial walls that resist shear stresses and improve marginal load distribution in the pulpal floor area³⁸.

When comparing the butt-joint design to the shoulder-with-ferrule design, the former is less complex and demonstrates superior marginal integrity and internal adaptation^{36,38}.

Nonetheless, studies evaluating the impact of the ferrule effect have reported conflicting results^{18,9}.

Some researchers have suggested that the shoulder design with a ferrule provides greater fracture resistance and reduces the incidence of catastrophic failures compared to the butt joint design^{18,36,38,9}.

Others, however, have reported no significant differences in stress distribution or fracture resistance between the two designs¹⁸.

According to Einhorn et al., incorporating a ferrule into endocrown preparation necessitates excessive dentin removal, thereby weakening the tooth-restoration complex⁴⁰.

Moreover, areas with reduced dentin wall thickness may lead to intaglio surface overmilling during CAD/CAM fabrication due to limitations in milling bur diameter.

Axial wall enamel reduction during preparation for the ferrule effect can also negatively affect adhesive cementation.

For optimal outcomes, all margins should remain supragingival, and any undermined enamel should be removed³⁶.

Preparation of the pulp chamber involves eliminating undercuts in the endodontic access cavity using a cylindrical-conical diamond bur with an approximately 7° occlusal taper, ensuring continuity between the access cavity and pulp chamber⁴¹.

The bur should be aligned parallel to the long axis of the tooth and used with minimal pressure to avoid unnecessary thinning of the chamber walls³⁶.

Regarding pulp chamber depth, several studies have reported that increasing the chamber depth does not enhance fracture resistance, but may instead lead to more catastrophic failures^{18,39,9}.

For the chamber floor, it is recommended to remove gutta-percha to a depth of approximately 2 mm to create a saddle-shaped anatomy, which enhances stability⁴². According to Alqarni et al., the availability of sufficient intracoronal space allows endocrowns with only a 2 mm intracoronal extension to achieve maximum fracture resistance.

In cases where the remaining tooth structure is short, endocrowns without intracoronal extensions may still represent a clinically acceptable alternative, offering a reduced risk of catastrophic failure⁴³.

However, extension into root canals has been associated with reduced stress distribution efficiency and decreased marginal and internal adaptation^{18,9}.

Since achieving reliable adhesion to dentin remains a clinical challenge, the use of immediate dentin sealing (IDS) is strongly recommended to improve dentin bonding and minimize microleakage⁴⁴.

In some cases, irregularities in the pulp chamber walls may need to be corrected with resin composite material to eliminate undercuts that could hinder the passive seating of the restoration³⁹.

The fundamental requirement for an ideal endocrown preparation is that all cavity surfaces-including walls and the chamber floor-should be visible from a single occlusal viewpoint, with no undercuts or divergent areas.

Summary of Key Recommendations for Endocrown Preparation:

- **Cuspal reduction:** 2–3 mm with 90° circumferential butt-joint margins (1–2 mm wide).
- **Cervical margins:** Positioned as supragingivally as possible.
- **Pulp chamber divergence:** 5–7° to ensure a continuous transition between the pulp chamber and endodontic access cavity.
- **Gutta-percha removal:** Up to 2 mm depth to maintain a saddle-shaped cavity floor.
- **Internal design:** Smooth internal transitions, a relatively flat chamber floor, and sealed radicular spaces.

Adhesive cementation

Adhesive cement plays a crucial role in the performance and longevity of endocrowns by providing micromechanical retention. Effective adhesion facilitates optimal stress distribution, thereby enhancing fracture resistance. However, failure of the adhesive interface may lead to complications such as microleakage, secondary caries and periodontal problems⁴⁵.

Resin cements are the material of choice for endocrown cementation due to their strong bonding potential, aesthetic properties, high mechanical strength, and low solubility. They are generally classified as conventional resin cements or self-adhesive resin cements. Conventional resin cements require multiple bonding steps, including surface conditioning of both the tooth and the restoration with etchants and bonding agents. Although these steps enhance adhesion, they also increase the procedure time and risk of contamination, making the technique more sensitive. To simplify the clinical protocol and eliminate the need for pretreatment, self-adhesive resin cements were introduced. However, several studies have reported that their bond strength is comparatively lower than that of conventional resin cements⁴⁶.

Resin cements can also be categorized according to their polymerization mode: self-cured, light-cured or dual-cured.

Self-cured resin cements have limited clinical applications because of their inferior mechanical and aesthetic properties and shorter working time.

Light-cured resin cements provide extended working time, but their effectiveness is limited to shallow preparations, as light penetration in deeper areas may be inadequate, increasing the risk of adhesive failure.

Dual-cured resin cements, combining both self-curing and light-curing mechanisms, are therefore considered ideal for deep cavities, offering excellent mechanical performance and adequate working time⁴⁷.

Polymerization of resin cement may be negatively affected by residual eugenol-containing root canal sealers; this issue can be mitigated by thorough cleaning and acid etching of the cavity walls before cementation.

After placement, it is essential to remove all excess cement, especially from subgingival margins, to avoid biological complications.

Radiographic verification may be performed to ensure that no residual cement remains⁴⁸.

Conclusion

Based on the reviewed literature, it can be concluded that endocrowns represent a reliable and minimally invasive prosthetic alternative for the restoration of severely damaged endodontically treated teeth. They are most commonly indicated for mandibular molars, particularly those with complex root canal anatomies-such as curved, narrow or calcified canals-where conventional post-and-core restorations are more challenging. Among the available materials, lithium disilicate ceramics remain the most frequently used, owing to their excellent adhesive bonding capabilities and favorable mechanical and aesthetic properties.

Endocrowns have demonstrated comparable or superior fracture resistance under both axial and lateral loading compared to traditional post-and-core systems.

Consequently, they are regarded as an optimal therapeutic solution for the functional and aesthetic reconstruction of extensively compromised endodontically treated teeth.

Reference

1. Kinney JH, Balooch M, Marshall SJ, Marshall GW Jr, Weihs TP. Atomic force microscope measurements of the hardness and elasticity of peritubular and intertubular human dentin. *J Biomech Eng.* 1996;118:133-135.
2. Chang C-Y, Kuo J-S, Lin Y-S, Chang Y-H. Fracture resistance and failure modes of CEREC end-crowns and conventional post and core supported CEREC crowns. *J Dent Sci.* 2009;4(3):110-117.
3. Balkenhol, M.; Wöstmann, B.; Rein, C.; Ferger, P. Survival time of cast post and cores: A 10-year retrospective study. *J. Dent.* 2007, 35, 50–58.
4. Goracci, C.; Ferrari, M. Current perspectives on post systems: A literature review. *Aust. Dent. J.* 2011, 56, 77–83.
5. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature, Part II (Evaluation of fatigue behavior, interfaces, and in vivo studies). *Quintessence Int.* 2008;39:117-129.
6. Al-Wahadni A, Gutteridge DL. An in vitro investigation into the effects of retained coronal dentine on the strength of a tooth restored with a cemented post and partial core restoration. *Int Endod J.* 2002;35:913-918.
7. D. Preethi, N. Gopi Chander, J Ramesh Reddy, P. Shanmuga priya, Aashmika Mahajan, K. S. Vigneshwaran. Endocrowns- a narrative review. *Journal of Pharmaceutical Negative Results* 2022, 3018-3025.
8. AlDabeeb DS, Alakeel NS, Al Jfshar RM, Alkhalid TK. Endocrowns: Indications, Preparation Techniques, and Material Selection. *Cureus.* 2023;15(12):e49947.
9. Govare N, Contrepolis M: Endocrowns: a systematic review. *J Prosthet Dent.* 2020, 123:411-8.e9.
10. Biacchi GR, Mello B, Basting RT. The endocrown: an alternative approach for restoring extensively damaged molars. *J Esthet Restor Dent* 2013;25(6):383–390.
11. Pissis P. Fabrication of a metal-free ceramic restoration utilizing the monobloc technique. *Pract Periodontics Aesthet Dent* 1995;7(5):83–94.
12. Fages M, Bennasar B. The endocrown: a different type of all-ceramic reconstruction for molars. *J Can Dent Assoc* 2013;79:d140.
13. Zhu J, Rong Q, Wang X, et al. Influence of remaining tooth structure and restorative material type on stress distribution in endodontically treated maxillary premolars: a finite element analysis. *J Prosthet Dent* 2017;117(5):646–655.
14. R. Menezes-Silva, C. A. V. Espinoza, M. T. Atta, M. F. L. Navarro, S. K. Ishikiriama, and R. F. L. Mondelli, "Endocrown: a conservative approach," *Brazilian Dental Science* 2016; 19(2).
15. Sevimli G, Cengiz S, Oruc MS: Endocrowns: review. *J Istanbul Univ Fac Dent.* 2015, 49:57.
16. Atash R, Arab M, Duterme H, et al. Comparison of resistance to fracture between three types of permanent restorations subjected to shear force: An in vitro study. *J Indian Prosthodont Soc* 2017;17(3):239–249.
17. Sedrez-Porto JA, Rosa WL, da Silva AF, et al. Endocrown restorations: a systematic review and meta-analysis. *J Dent* 2016;52:8–14.
18. Ciobanu P, Manziuc MM, Buduru SD, Ducea D: Endocrowns - a literature review. *Med Pharm Rep.* 2023;96:358-67.
19. Sağlam G, Cengiz S, Karacaer Ö: Marginal adaptation and fracture strength of endocrowns manufactured with different restorative materials: SEM and mechanical evaluation. *Microsc Res Tech.* 2021, 84:284-90.
20. Gresnigt MM, Özcan M, van den Houten ML, Schipper L, Cune MS. Fracture strength, failure type and Weibull characteristics of lithium disilicate and multiphase resin composite endocrowns under axial and lateral forces. *Dent Mater.* 2016;32(5):607-614.
21. Tribst JPM, Dal Piva AMO, Madruga CFL, et al. Endocrown restorations: Influence of dental remnant and restorative material on stress distribution. *Dent Mater.* 2018;34(10):1466-1473.
22. Conrad H, Seong W, Pesun I : Current ceramic materials and systems with clinical recommendations: a systematic review. *J Prosthetic Dentistry.* 2007, 98:389-404.
23. Thomas RM, Kelly A, Tagiyeva N, Kanagasingam S: Comparing endocrown restorations on permanent molars and premolars: a systematic review and meta-analysis. *Br Dent J.* 2020, 1-9.
24. P. Zoidis, E. Bakiri, and G. Polyzois, "Using modified polyetheretherketone (PEEK) as an alternative material for endocrown restorations: a short-term clinical report," *The Journal of Prosthetic Dentistry* 2017;117(3):335–339.
25. ElHamid ARA, Masoud GI, Younes AA: Assessment of fracture resistance, marginal and internal adaptation of endocrown using two different heat-press ceramic materials: an in-vitro study. *Tanta Dent J.* 2023,20:196-202.
26. El Ghoul W, Özcan M, Silwadi M, Salameh Z: Fracture resistance and failure modes of endocrowns manufactured with different CAD/CAM materials under axial and lateral loading. *J Esthet Restor Dent.* 2019, 31:378-87.
27. Sahebi M, Ghodsi S, Berahman P, Amini A, Zeighami S: Comparison of retention and fracture load of endocrowns made from zirconia and zirconium lithium silicate after aging: an in vitro study. *BMC Oral Health.* 2022, 22:41.
28. Soliman M, Alzahrani G, Alabdualataif F, et al.: Impact of ceramic material and preparation design on marginal fit of endocrown restorations. *Materials.* 2022, 15-5592.
29. Dejak B, Mlotkowski A. A comparison of mvM stress of inlays, onlays and endocrowns made from various materials and their bonding with molars in a computer simulation of mastication - FEA. *Dent Mater.* 2020;36:854-864.
30. Lin J, Lin Z, Zheng Z. Effect of different restorative crown design and materials on stress distribution in endodontically treated molars: a finite element analysis study. *BMC Oral Health.* 2020;20:226.
31. Dartora NR, Mauricio Moris IC, Poole SF, Bacchi A, Sousa Neto MD, Silva-Sousa YT, et al. Mechanical behavior of endocrowns fabricated with different CAD-CAM ceramics systems. *J Prosthet Dent.* 2021;125:117-125.
32. Taha D, Spintzyk S, Sabet A, Wahsh M, Salah T. Assessment of marginal adaptation and fracture resistance of endocrown restorations utilizing different machinable blocks subjected to thermomechanical aging. *J Esthet Restor Dent.* 2018;30:319-328.
33. Bankoğlu Güngör M, Turhan Bal B, Yılmaz H, Aydın C, Karakoca Nemli S. Fracture strength of CAD/CAM fabricated lithium disilicate and resin nano ceramic restorations used for endodontically treated teeth. *Dent Mater J.* 2017;36:135-141.
34. Zheng Z, He Y, Ruan W, Ling Z, Zheng C, Gai Y, Yan W. Biomechanical behavior of endocrown restorations with different CAD-CAM materials: A 3D finite element and in vitro analysis. *J Prosthet Dent.* 2021;125:890-899.
35. Rocca GT, Krejci I. Crown and post-free adhesive restorations for endodontically treated posterior teeth: from direct composite to endocrowns. *Eur J Esthet Dent* 2013;8(2):156–179.
36. Elagra, M. Endocrown preparation. *Int J Appl Dent Sci.* 2019, 5:2536.

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37. Bhalla VK, Chockattu SJ, Srivastava S. Decision making and restorative planning for adhesively restoring endodontically treated teeth: an update. *Saudi Endodont J.* 2020, 10:1816.
 38. Adel S, Abo-Madina MM, Abo-El Farag SA. Fracture strength of hybrid ceramic endocrown restoration with different preparation depths and designs. *IOSR J Dent Med Sci.* 2019, 18:17-23.
 39. AL-Zomur S, Abo-Madina M, Hassouna M. Influence of different marginal preparation designs and material on the marginal integrity and internal adaptation of endocrown restorations. *Egypt Dental J.* 2021, 67:3491- 500.
 40. Einhorn M, DuVall N, Wajdowicz M, et al. Preparation ferrule design effect on endocrown failure resistance. *J Prosthodont.* 2019, 28(1):e237–e242.
 41. Singh A, Abrol K, Agarwal S. Endocrown restorations: a review. *Chron Dental Res.* 2016, 8:21-6.
 42. Papalexopoulos D, Samartzi TK, Sarafianou A: A thorough analysis of the endocrown restoration: a literature review. *J Contemp Dental Pract.* 2021, 22:422-6.
 43. Alqarni H, Qadoumi M, AlShehri N, AlNowaiser N, Alaqeely R, AlHelal AA, Alrabiah M, Alshihri A, Alsayed H. Resistance of Resin-Bonded Ceramic Endocrowns of Different Intracoronary Depths. *Oral Health Prev Dent.* 2025 Jan 22;23:51-58.
 44. Perdigo J. Dentin bonding-variables related to the clinical situation and the substrate treatment. *Dent Mater.* 2010;26(2):e24–e37.
 45. He J, Zheng Z, Wu M, Zheng C, Zeng Y, Yan W. Influence of restorative material and cement on the stress distribution of endocrowns: 3D finite element analysis. *BMC Oral Health.* 2021, 21:495
 46. Emam ZN, Elsayed SM, Abu-Nawareg M. Retention of different all ceramic endocrown materials cemented with two different adhesive techniques. *Eur Rev Med Pharmacol Sci.* 2023, 27:2232-40.
 47. Sultan SEK. The Effect of Cementation Techniques and Surface Treatments on the Retention of Hybrid Ceramic Endocrowns. Tanta University, Al Gharbiyah; 2018.
 48. El-Ma'aita A, Al-Rabab'ah M, Abu-Awwad M, Hattar S, Devlin H. Endocrowns clinical performance and patient satisfaction: a randomized clinical trial of three monolithic ceramic restorations. *J Prosthodont.* 2022, 31:30-7.