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Restorative Strategies for Endodontically Treated Teeth: A Comprehensive Review

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Abstract

Background: The restoration of endodontically treated teeth (ETT), particularly those with significant coronal loss, remains a clinical challenge. Traditionally, post-and-core-supported full coverage crowns were considered the gold standard. However, advancements in adhesive dentistry and restorative materials have led to a paradigm shift toward more conservative and biomimetic approaches, including endocrowns and overlays. This review aims to evaluate current evidence on restorative strategies for ETT, emphasizing adhesive, post-less options like endocrowns and overlays. It also highlights the biomechanical considerations, material advancements, and preparation designs that influence clinical outcomes.

Methods: This narrative review was conducted by searching PubMed, Scopus, and Google Scholar for English-language articles up to June 2025. Keywords included: "endodontically treated teeth," "endocrowns," "overlays," "fiber-reinforced composites," "biomimetic restorations," and "fracture resistance." Eligible studies focused on mechanical behavior, clinical performance, material comparisons, and restoration design for ETT.

Conclusion: Conservative adhesive restorations—especially endocrowns and overlays—offer viable alternatives to traditional post-core crowns in ETT, provided that case selection, isolation, and bonding protocols are meticulously followed. Biomimetic materials, such as fiber-reinforced composites and advanced ceramics, enhance stress distribution and contribute to favorable fracture patterns. Endocrowns are particularly effective for posterior teeth with sufficient pulp chamber depth. Despite encouraging outcomes, further clinical trials are needed to define optimal treatment strategies for compromised cases with minimal remaining tooth structure.

Keywords: Endodontically treated teeth (ETT), Endocrowns, Overlays, Adhesive Dentistry, Biomimetic Restorations, Fiber-reinforced composites (FRCs).

Introduction

Restoration of endodontically treated teeth (ETT) with coronal loss is debatable nowadays. For many years, dentists always used to restore them with conventional crowns retained with post and core.[1, 2] We used to think that this would reinforce the remaining tooth structure.[3] However, posts insertion can weaken the tooth structure as a result of dentin removal and the aggressive preparation during drilling.[4]

Recently, with the advancement in ceramic materials and adhesive dentistry, the need of using post and core became less evident.[5-8] Etchable ceramics and adhesives enabled the dentist to use adhesive partial coverage restorations with no need for the invasive preparation of the full coverage crowns.[9] Endocrowns and overlays invaded the dental field in the last few years, we can now use monolithic endocrowns to restore ETT depending on the pulp chamber for retention without using posts according to the literature.[10-12] Moreover, the current literature suggests the use of overlays in ETT with a bioadhesive base to mimic the natural behavior of sound teeth.[13]

The restoration of non-ideal endodonticaly treated teeth is hardly discussed in the literature and in-vitro studies. Challenging clinical cases with minimum wall height, ferrule and thickness are not well emphasized. Moreover, there's no enough evidence on the best methodology or selection criteria clinicians should follow when restoring badly decayed tooth structure. Many studies show the success rate of endocrowns in endodontically treated molars rather than conventional post and core and crown.[14] Endocrowns show lower success rates in premolars compared to post-and-core crowns due to dominant lateral forces and a reduced height-to-width ratio, which creates a longer lever arm and increases stress on the restoration.[15]

In this manner, Al-Dabbag [16] conducted a systematic review based on three clinical and seven in vitro studies, the estimated 5-year survival rates were 91.4% for endocrowns and 98.3% for conventional crowns, while success rates were 77.7% and 94%, respectively. Despite slightly lower figures for endocrowns, the differences were not statistically significant. The findings suggest that endocrowns offer a conservative and acceptable long-term alternative, though further high-quality clinical research is needed.

Sedrez-Porto et al. [14] reported that endocrowns often exhibit above-CEJ fractures or debonding, which are restorable, whereas post-retained crowns more frequently result in irreparable root fractures. Similarly, Rocca et al. [17] found that resin-nanoceramic endocrowns showed marginal defects and adhesive failures rather than catastrophic fractures, while post-core crowns demonstrated vertical root fractures. An in-vitro study by Aktas et al. [18] also confirmed that lithium disilicate endocrowns fail predominantly by cohesive or adhesive fractures within the restoration, which can be replaced, unlike the unfavorable root fractures common in post-core restorations.

Clinical studies echo these findings. Zou et al. [19] compared monolithic zirconia endocrowns with post-core crowns over a 5-year follow-up and noted that while survival rates were similar, endocrowns presented repairable debonding or ceramic chipping, whereas post-core crowns were more likely to fail irreversibly due to root or post fractures. Likewise, Govare & Contrepois [20] in their systematic review highlighted that endocrowns, despite slightly lower survival, had the distinct advantage of failing in a less destructive manner, thereby improving retreatment options.

Indirect composite and lithium disilicate CAD/CAM blocks are commonly used for fabricating endocrowns and overlays. However, hybrid materials are often favored because they combine properties of both composites and ceramics, offering the benefits of each.[21]

Recently, biomimetic dentistry had a wide spread in the dental field. Biomimetic dentistry is known as the art and science of restoring damaged teeth and use materials that mimic the properties of natural teeth—strength, appearance, and function to restore the tooth as close to its natural harmony, physically and biomechanically.[22] The concept relies on using composite materials with an elastic modulus similar to dentin for dentin replacement, while ceramics—with their high hardness—serve as enamel substitutes. When bonded effectively, these materials integrate as a unified structure, functioning harmoniously with the remaining tooth.

With the advanced of biomimetic dentistry, fiber materials have been introduced in dentistry to increase the fracture strength of composite due to their low modulus of elasticity that absorb and transfer stress in fiber well and lead to more favorable fracture pattern due to the fiber layer act as stress breaking, increase bond strength, decrease C factor and polymerization shrinkage.[23]

This review aims to critically evaluate the current evidence regarding restorative options for ETT, with particular emphasis on the role of adhesive, post-less restorations such as endocrowns and overlays. It further explores the biomechanical principles, material properties, and preparation designs that influence long-term success and fracture resistance in the restoration of structurally compromised teeth.

Methodology of the Review

This narrative review was conducted through a comprehensive literature search of peerreviewed articles published in English up to June 2025. Databases including PubMed, Scopus, and Google Scholar were queried using combinations of the following keywords: "endodontically treated teeth," "endocrowns," "fiber-reinforced composites," "adhesive dentistry," "biomimetic restorations," and "fracture resistance." Inclusion criteria were studies discussing restorative options for ETT, their mechanical and clinical performance, material comparisons, and biomimetic principles.

Endodontically Treated Teeth and Their Restoration Challenges

ETT differ significantly from vital teeth due to structural, mechanical, and sensory changes resulting from treatment procedures. The restoration of these teeth is a complex clinical task requiring a multidisciplinary approach encompassing endodontics, operative, and prosthetic dentistry. These restorations not only replace the tissue lost during treatment but also play a critical role in the long-term prognosis, which depends on both the endodontic success and the quality of the final restoration.[24, 25]

Several factors contribute to the weakening of ETT. These teeth often have a history of extensive caries, trauma, or previous restorations that compromise tooth integrity even before root canal therapy begins.[26] A primary concern is the increased susceptibility to fracture, not solely due to the treatment itself, but because of significant structural loss, including dentin removal, marginal ridge destruction, and dehydration of dentin. While dentin in treated teeth retains about 9% less moisture than that in vital teeth, the predominant cause of weakening remains the loss of structural integrity rather than dehydration alone.[27, 28]

Chemical agents used during treatment, such as sodium hypochlorite and EDTA, can further degrade dentin by reducing its strength, elasticity, and hardness, especially when used excessively or in combination. This degradation is compounded by the loss of proprioceptive feedback after pulp removal, which reduces protective responses during mastication, thereby increasing functional overload and fracture risk.[29, 30] Studies like those by Patel et al. [31] and Sornkul & Stannard [32] confirm that structural and sensory loss due to endodontic procedures significantly reduces fracture resistance in affected teeth.

Aesthetic challenges also arise, particularly in anterior teeth, where discoloration may occur due to remnants of root filling materials in the pulp chamber. Materials such as iodoform or silver-based pastes are particularly prone to causing tooth darkening. To mitigate this, it is essential to clean the pulp chamber thoroughly and avoid leaving materials close to the enamel-cementum junction.[33]

Restoration types for ETT

The restoration approach for ETT is largely dictated by the amount of remaining tooth structure. The more tooth tissue preserved, the better the long-term prognosis.[34] Restorative options range from conventional post, core, and crowns, endocrowns, and partial coverage restorations: inlays, onlays and overlays.

I. Conventional post, core, and crown

Posts are indicated when residual coronal tooth structure is insufficient to retain a core buildup. While it is widely believed that posts do not reinforce teeth, recent randomized clinical trials challenge this view, showing improved survival rates in ETT restored with fiber posts and crowns compared to those without posts.[35, 36] Aesthetic glass and quartz fiber posts have largely replaced carbon fiber ones, offering favorable properties and an elastic modulus closer to dentin. Fiber posts bond to the composite core through micromechanical retention provided by surface irregularities. Their failure mode tends to be reparable debonding rather than root fracture, offering a conservative advantage over metal posts.[37]

Full coverage crowns remain a primary choice for restoring ETT. Porcelain-fused-to-metal (PFM) crowns have long been used for posterior teeth due to their robust metal substructure and acceptable esthetics. However, drawbacks such as porcelain chipping and esthetic limitations in cases of gingival recession are noted.[38] All-ceramic crowns, especially lithium disilicate types (e.g., IPS e.max), offer a superior blend of strength and esthetics, making them suitable for both anterior and posterior restorations. Their enamel-like translucency improves natural appearance, although they require meticulous adhesive techniques and occlusal management to prevent fractures.[39, 40] Monolithic zirconia crowns, fabricated from a single block of zirconia, eliminate the veneering layer and minimize chipping risk. These crowns are highly durable, ideal for posterior molars and bruxism cases, and recent developments in translucency have expanded their use to esthetic zone.[41, 42]

II. Endocrowns

Endocrowns represent a conservative restorative option for ETT, especially when avoiding the use of intraradicular posts. These restorations utilize the pulp chamber for macromechanical retention and adhesive bonding without reducing the axial walls, thus preserving radicular dentin.[43] Initially introduced as a corono-radicular monoblock restoration in 1999, endocrowns have gained popularity with the advent of CAD/CAM technology due to reduced preparation time and lower cost compared to traditional post-core crowns.[44, 45] They are especially useful in cases with short, calcified, or curved canals. Mechanically, high-modulus materials in endocrowns concentrate stress within the restoration, while flexible materials shift stress to the adhesive layer, increasing failure risk. Though endocrowns perform well under axial loading, conventional full crowns may outperform them under oblique forces.[46, 47]

Endocrowns is a part of the "monoblock technique," which utilized the pulp chamber for retention rather than relying on intraradicular posts. Bindl and Mormann later coined the term "endocrown." This approach emerged to overcome complications associated with traditional postcore systems, such as root perforation and structural weakening.[11, 29] The integration of CAD/CAM technology further advanced endocrown adoption, enabling minimally invasive, precise restorations that preserve more tooth structure—especially in molars with extensive damage— while offering comparable survival rates to post-retained crowns.[48]

A. Indications

Endocrowns are indicated for teeth with extensive coronal structure loss and limited interocclusal space, where conventional crowns may not achieve optimal thickness. They are particularly beneficial when a ferrule is not feasible or in anatomically challenging cases, such as teeth with short roots, calcified or curved canals, or fractured instruments that prevent post placement.[49]

B. Contraindications

Contraindications include cases with severe subgingival damage, shallow pulp chambers (<2 mm depth), or insufficient bonding surface, which limit adhesion. Endocrowns are also not recommended in patients with parafunctional habits, like bruxism, where lateral forces and steep cusps increase the risk of failure.[50, 51]

C. Preparation

Endocrowns achieve retention through bonding to the pulp chamber and surrounding margins. Unlike traditional crowns, preparation is more conservative but must be tailored to the restorative material and biomechanical needs.[52]

1. Occlusal and External Axial Wall Preparation

For ceramics, at least 2 mm occlusal reduction is required, while composites need only 1–1.5 mm due to their stress-absorbing properties. Thickness usually ranges from 3–7 mm depending on material and case demands.[49, 53] A butt joint margin (90° enamel band, 1–2 mm wide) enhances bonding and stress resistance. Guide grooves and wheel burs aid in achieving parallel and flat occlusal surfaces.[54]

2. Ferrule Effect

Although endocrowns traditionally omit a ferrule, some designs incorporate a short axial shoulder margin for added stress control. This 1 mm wide shoulder in sound enamel can improve marginal integrity and load distribution. However, studies report mixed outcomes—some show increased fracture resistance with ferrule use, while others find no significant difference compared to simpler butt joint designs.[54, 55] Regardless of design, margins should ideally remain supragingival, and unsupported enamel should be removed.[20]

3. Pulp Chamber Preparation

Pulp chamber walls are prepared using a conical bur with a 7° taper, avoiding excessive pressure to preserve dentin. Chamber depth beyond 2 mm does not enhance fracture resistance and may lead to more severe failures. Removing 2 mm of gutta-percha to create a stable floor ("saddle anatomy") is advised. Extending into root canals may impair stress distribution and adaptation.[56] While some studies recommend immediate dentin sealing and composite filling of chamber irregularities for improved adhesion, others report no added benefit in fracture resistance.[20, 57]

III. Partial coverage restorations

Partial coverage restorations are more conservative than full crowns, preserving 32–47% of tooth structure versus 70–75% with crowns. They include inlays, onlays, and overlays. Inlays, though conservative and precise, are rarely recommended for ETT due to insufficient reinforcement of weakened cusps.[58] Onlays offer extended coverage, preserving tooth tissue while reinforcing compromised cusps. They are indicated in cases of moderate structural loss and can be fabricated from ceramics like lithium disilicate for increased fracture resistance.[59] Overlays provide full cuspal coverage without encompassing the axial surfaces, suitable for molars with weakened marginal ridges but preserved vertical height. Advances in CAD/CAM ceramics and adhesive bonding have enhanced the clinical reliability of overlays.[60]

Cuspal coverage becomes essential in endodontically treated teeth because the cumulative loss of tooth tissue from caries, access preparation, and previous restorations significantly weakens the tooth. The marginal ridges and cusps, in particular, are prone to flexure under occlusal load. If left unprotected, these weakened cusps may fracture catastrophically, often rendering the tooth non-restorable.

1. Inlay

An inlay is an indirect restoration that is confined to the central portion of the tooth and does not involve cuspal coverage. It is typically used to restore small to moderate-sized cavities within the occlusal surface and proximal areas, fitting between the cusps without reducing them.[61] Inlays are fabricated from composite, ceramic, or metal and then adhesively bonded to the tooth. While inlays are highly conservative and can provide excellent marginal adaptation and esthetics, their use in endodontically treated teeth is limited. This is because ETT generally require reinforcement of weakened cusps due to the loss of structural integrity from caries, endodontic access, and preparation. Without cuspal coverage, inlays do not sufficiently prevent cusp deflection under occlusal forces, which predisposes the tooth to vertical or catastrophic fractures.[57, 62]

2. Onlay

An **onlay** is a partial coverage restoration that extends beyond the occlusal surface and covers **at** least one cusp. It is often described as a "cusp-covering inlay," offering reinforcement to weakened cusps while preserving as much sound tooth structure as possible [63]. Onlays are indicated when a tooth has moderate loss of coronal tissue, such as when one or more cusps are undermined or fractured. By incorporating cuspal coverage, onlays redistribute functional stresses across the tooth-restoration complex and protect fragile cusp tips from fracture. For endodontically treated posterior teeth, onlays are particularly valuable, as they provide mechanical reinforcement while avoiding the extensive circumferential reduction required for full crowns. The adhesive bonding of ceramic or composite onlays further improves stress distribution, enhances fracture resistance, and promotes a biomimetic restoration that more closely replicates the natural biomechanical behavior of the tooth.[64, 65]

3. Overlays

An overlay covers all cusps but spares the axial walls, offering full cuspal protection with minimal tooth reduction. Overlays are indicated when cusp thickness is reduced (<2 mm in vital teeth, <3 mm in ETT) or when marginal ridges are compromised.[66] Overlays represent a minimally invasive, biomimetic solution for posterior restorations. They protect compromised cusps while preserving healthy tooth structure, especially in cases of ETT, worn dentition, or cracked tooth syndrome. Overlays are typically recommended when cusp thickness is <2 mm in vital teeth or <3 mm in non-vital teeth.[67] When properly bonded, overlays show success rates comparable to full crowns, with survival often exceeding 90%. Failures are mostly due to ceramic fractures, decementation, or caries, but overall performance remains excellent when modern adhesive techniques are used.[68, 69]

Overlay preparations are more conservative than full crowns, preserving 32–47% of tooth structure versus 70–75% with crowns. Key preparation principles include uniform occlusal reduction, smooth transitions, and supragingival enamel margins to enhance bonding.[59] The design maintains the compression dome (enamel above the contour line handling compressive forces) and bio-rim (from contour to CEJ managing tensile forces), both critical for biomechanical performance and longevity.[70, 71] Biomimetic preparation helps avoid crack propagation into roots and aligns with the natural stress-bearing behavior of the tooth, improving restoration lifespan.[72]

Factors Affecting Choice of Restoration Design I. Remaining tooth structure

The choice of restoration design for ETT is primarily influenced by the amount of remaining tooth structure and the tooth's location. Anterior teeth with minimal access cavity preparation and sufficient coronal structure can often be restored using direct composite restorations without requiring full coverage. In contrast, posterior teeth—which endure higher occlusal stresses due to their anatomy—almost always require cuspal coverage. Teeth with significant coronal loss are typically treated using a core buildup and crown. When coronal structure is insufficient to retain the core, a post (prefabricated or custom-made) may be considered to secure the restoration. However, some studies indicate that teeth restored with or without posts exhibit similar failure modes and fracture resistance, suggesting that posts may not always be necessary.[29, 56]

Clinical decision-making varies widely depending on remaining structure. For example, when more than 50% of coronal structure is lost, some clinicians advocate using a root post to retain the core and distribute occlusal stress. Nonetheless, this recommendation is based more on mechanical retention needs rather than any reinforcing effect of the post, which does not inherently strengthen the tooth.[73] The diversity of approaches is highlighted in a study by Türp et al. [74], where four specialists gave different recommendations for restoring a fractured lateral incisor, underscoring the lack of consensus among clinicians. Ultimately, the remaining tooth structure and functional demands are key determinants for selecting between direct vs. indirect restorations, post placement, and restorative materials.

II. Bonding

Bonding is a critical determinant in the long-term success of adhesive restorations like overlays and endocrowns in ETT. As these teeth often have compromised structure, the bonding interface must effectively resist functional stresses and prevent microleakage. Proper bonding techniques involve conditioning of both the tooth surface and the restoration using etchants, primers, and resin cements. Immediate dentin sealing (IDS) has been introduced to improve adhesive performance and reduce post-operative sensitivity. This technique involves applying a dentin bonding agent to freshly cut dentin immediately after tooth preparation and prior to impression-taking. Studies have shown that IDS significantly enhances bond strength—up to 90 MPa—compared to 30–50 MPa with delayed sealing.[75-77]

To ensure success, a meticulous bonding protocol is required. This includes effective isolation, surface cleaning, selective enamel or total dentin etching, and application of compatible primers and adhesives, followed by proper light curing. For indirect restorations, the internal surface is also treated with sandblasting and silanization, followed by resin cement application. Adhering to such detailed protocols improves stress distribution, increases fracture resistance, and minimizes the risk of restoration debonding and failure.[78, 79]

III. Isolation

Maintaining effective isolation is indispensable during adhesive procedures, especially when restoring ETT with indirect restorations. Moisture contamination can compromise the bond strength and lead to restoration failure by preventing proper adhesive infiltration and polymerization. The rubber dam is considered the gold standard for isolation, providing a clean and dry working field that minimizes contamination from saliva, blood, or gingival fluids—especially critical in subgingival margins or deep cavities.[78] In cases where rubber dam use is impractical, alternative methods such as gingival retraction cords, liquid dams, or commercial isolation systems may be employed, though often with reduced reliability. Regardless of the method, achieving consistent and effective isolation is fundamental to the success of adhesive bonding.[80]

IV. Materials

The choice of material plays a crucial role in the long-term performance of adhesive restorations for ETT. Various materials have been utilized, including lithium disilicate glassceramics, zirconia-reinforced lithium silicate (ZLS) ceramics, hybrid ceramics, monolithic zirconia, resin composites, and fiber-reinforced composites. Each material differs in mechanical properties, esthetic outcomes, bonding potential, and clinical performance.[81, 82]

1. Lithium Disilicate Glass-Ceramic

Lithium disilicate ceramics are widely favored for their excellent mechanical properties and natural esthetics. Comprising about 70% needle-like crystals within a glass matrix, lithium disilicate demonstrates a flexural strength of 360–400 MPa and fracture toughness of 2.5–3.0 MPa·m^0.5, with low porosity and a density around 2.5 g/cm³.[83] These characteristics make it resistant to crack propagation, particularly under lateral forces. Its high translucency (28–44%) and range of opacity levels allow superior shade matching and enamel mimicry.[84] Long-term clinical studies report survival rates of 94–96% over 5 years and 89–95% over 10 years, supporting its reliability in both anterior and posterior restorations.[85, 86]

2. Advanced Lithium Disilicate (ALD)

Advanced lithium disilicate (e.g., CEREC Tessera) integrates lithium disilicate and virgilite crystals, offering faster crystallization (as short as 4.5 minutes) and higher strength. ALD materials show flexural strength up to 700 MPa and fracture toughness between 2.75–3.2 MPa·m^0.5, making them suitable for stress-bearing regions like posterior crowns.[87] They maintain good esthetics with 30–40% translucency, fine optical integration, and multiple shade options. Although long-term data is limited, short-term results report >95% survival within 1–3 years, suggesting promising clinical potential.[88]

3. Zirconia-Reinforced Lithium Silicate Glass-Ceramic (ZLS)

ZLS ceramics enhance mechanical strength by incorporating 8–12% zirconia, achieving flexural strength of 370–420 MPa and improved resistance to crack propagation.[51] However, the zirconia content reduces surface reactivity, limiting etchability and resulting in 20–30% lower bond strength compared to traditional lithium disilicate, as shown by Elsoudany et al. [89] and Alva et al. [90]. Its high modulus of elasticity (70–75 GPa) may focus stress at the tooth-restoration interface, potentially increasing failure risk in compromised teeth.[91]

4. Zirconia

Zirconia, a polycrystalline ceramic devoid of glass phases, is valued for its exceptional strength, making it ideal for high-load cases like bruxism. However, it lacks the ability to be etched using conventional methods, which reduces bond strength and increases the likelihood of debonding. Furthermore, zirconia restorations have been linked with the highest incidence of catastrophic failures among ceramic materials.[92]

5. Resin Composite Materials

Resin composites serve as a more elastic alternative to ceramics, with mechanical properties closer to dentin. Their lower modulus enables better stress distribution and more favorable failure patterns.[93] They are also intraorally repairable and easier to adjust. Despite this, a study by Yazdi et al. [94] found that while both direct and indirect composite onlays had similar fracture resistance, they could not match the strength of intact teeth. Additionally, indirect onlays showed a higher frequency of irreparable fractures.

Composite resin restorations, particularly in the form of onlays, follow principles similar to those for vital teeth. Preparations should include rounded internal angles, a 90° shoulder finish, and a minimum depth of 1.5 mm. Cuspal coverage is recommended to reduce fracture risk.[95] Proper sealing of the pulp chamber with composite or glass-ionomer material facilitates a flat preparation base, improves impression quality, and enhances final restoration fit. Final restorations, including ceramic crowns or onlays, are typically bonded with adhesive resins for optimal performance.[96, 97]

6. Fiber-Reinforced Composites (FRC)

Fiber-reinforced composites incorporate materials like glass, polyethylene, or carbon fibers into a resin matrix to enhance strength and crack resistance. FRCs show flexural strengths ranging from 500–800 MPa and a modulus of elasticity (18–25 GPa) similar to dentin, allowing for better stress dissipation and reduced risk of catastrophic failure. Treated or pre-impregnated fibers offer strong adhesion and compatibility with resin systems, and glass FRCs also achieve good esthetics due to their translucency. These materials are light, customizable chairside, and particularly suited for minimally invasive approaches.[98, 99] In an in-vitro study by Youssef et al. [100], fracture resistance in maxillary premolars restored with either direct composite or indirect ceramic onlays was assessed. Although fracture strength was similar between the two, ceramic onlays showed significantly more irreparable fractures (P=0.005), suggesting FRCs may offer a safer failure pattern.

Role of EverX Under Overlays

GC everX Posterior is a fiber-reinforced composite (FRC) designed to replace dentin in large posterior restorations. It contains short, randomly oriented E-glass fibers in a semiinterpenetrating polymer network that enhances toughness, controls polymerization shrinkage, and reduces microleakage.[101-103] EverX Posterior supports the overlying composite or ceramic restoration and provides high fracture toughness—comparable to dentin and nearly double that of conventional composites. Its bulk-fill capability (4–5 mm) and strong bonding properties make it especially suited for extensive cavities, cusp replacement, ETT, and situations where onlays or inlays would otherwise be required.[104, 105]

Biomechanics for ETT

ETT often suffer from reduced structural integrity due to cumulative loss of tissue from caries, cavity preparation, and dentin alteration. This leads to decreased resistance to functional loads and increased fracture risk. Effective restorative designs must compensate for this by redistributing stresses, reinforcing weak zones, and preserving remaining tooth structure.[80] The loss of key elements like the pulp chamber roof and coronal dentin compromises the tooth's natural ability to absorb and dissipate forces, especially at the coronal-radicular junction, making these areas more prone to vertical fractures and cusp deflection.[106]

To restore biomechanical function, adhesive restorations such as overlays and endocrowns are favored for their monoblock behavior—creating a unified structure with the tooth and reducing stress concentrations. The material's elastic modulus also affects outcomes; high-modulus ceramics like lithium disilicate resist compression but may stress the bonding interface, while fiber-reinforced composites, with dentin-like flexibility, better distribute loads and fail in more favorable, repairable ways.[107, 108]

Compression Dome Concept

The "compression dome" model likens posterior teeth to architectural domes, where enamel above the height of contour channels forces down to the cervical area and periodontal support. Loss of key structures such as marginal ridges or the pulp chamber roof disrupts this dome and shifts stress apically, increasing cervical stress and fracture risk.[108, 109] Restorations that replicate this architecture—especially bonded overlays and endocrowns using fiber-reinforced or ceramic materials—can restore structural integrity and help withstand masticatory forces.[65, 110]

Finite element analyses have supported these biomechanical principles. Huang et al. [111] examined endocrown designs in molars with varying mesial wall defects. Under vertical and oblique loading, models with wall defects at the CEJ showed the highest stress in the cement layer and dentin, particularly in peri-cervical zones—highlighting the vulnerability of compromised areas. Similarly, Darwich et al. [112] compared materials using 3D FEA and found that translucent zirconia endocrowns concentrated stress within the restoration but spared the tooth, while resin nanoceramics caused greater stress and displacement in the tooth-restoration complex. Oblique loading, in all cases, produced higher stress and deformation, reinforcing the need for biomechanically responsive materials and designs.

Conclusions

The restoration of ETT has evolved significantly, shifting from traditional post-and-core crowns to conservative, biomimetic approaches like endocrowns and overlays. The success of these modern restorations lies in proper case selection, preservation of tooth structure, effective bonding protocols, and use of materials that closely mimic the mechanical behavior of dentin and enamel. Endocrowns, in particular, present a viable option in posterior teeth with sufficient pulp chamber depth and remaining dentin. Emerging technologies like CAD/CAM blocks and advanced FRCs continue to refine restorative strategies.

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