

RATIONALE FOR SELECTION OF DENTAL MATERIALS FOR RESTORING ENDODONTICALLY TREATED TOOTH- A NARRATIVE REVIEW

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ABSTRACT

Because of their degraded biomechanical characteristics—such as decreased fracture resistance, changed moisture content, and structural loss—endodontically treated teeth (ETT) pose a special challenge for restoration. For an ETT restoration to be long-lasting, functional, and aesthetically pleasing, the right dental materials must be chosen. As a result, this narrative review analysis assesses the justification for material selection using clinical data, functional requirements, and biomechanical principles.

Key Words: Endodontically treated teeth, Restorative materials, Composite resin, Lithium disilicate, Zirconia, Fiber post, Fracture resistance, Adhesive bonding.

1. INTRODUCTION

A tooth that has received endodontic therapy, also known as root canal therapy, to remove damaged or infected pulp, clean the root canal system, and then seal it with a biocompatible substance to stop reinfection is known as an endodontically treated tooth (ETT). The goal of this procedure is to remove discomfort and infection while maintaining the tooth's structure and function. [1]

Characteristics of an Endodontically Treated Tooth [2]

1. Loss of Pulp Vitality – The pulp tissue inside the tooth is removed.
2. Altered Biomechanics – The tooth may become more brittle due to loss of moisture and structural integrity.
3. Increased Fracture Risk – Depending on the remaining tooth structure, ETT may be more susceptible to fractures.
4. Restorative Needs – Often requires crowns or posts for reinforcement, especially for posterior teeth.

Clinical Aspects to Consider [3]

- Fracture Resistance: Research indicates that ETTs are less resistant to fracture than essential teeth, particularly in cases when a substantial amount of tooth structure is destroyed.
- Post-Endodontic Restoration: A sufficient coronal seal using restorative materials such as crowns, onlays, or composite is essential to the outcome of treatment.
- Longevity: Although well-restored ETT have a high survival rate, they still need to be regularly checked.

Restoration of Endodontically Treated Teeth (ETT)

For long-term success, endodontically treated teeth (ETT) must be restored in order to avoid reinfection, fractures, and structural failure. The remaining tooth structure, occlusal stresses, and aesthetics are some of the elements that influence the restoration option. [4]

1. Factors Influencing Restoration Choice

a. Amount of Remaining Tooth Structure

Minimal loss → Direct composite or onlay

Moderate loss → Cuspal coverage restoration (onlay/crown)

Severe loss → Post- core and crown

b. Tooth Location

Anterior teeth: Esthetic concerns → Composite or ceramic crowns

Posterior teeth: High occlusal load → Full-coverage crown recommended

c. Ferrule Effect

A 1.5–2 mm circumferential ferrule (tooth structure above gingival margin) improves fracture resistance.

2. Restoration Options [5]

A. Direct Restorations (Composite Resin)

Used for anterior teeth or minimally damaged posterior teeth.

Advantages: Conservative, esthetic, and cost-effective.

Disadvantages: Less fracture resistance compared to indirect restorations.

B. Indirect Restorations (Onlays, Crowns, and Endocrowns) [6]

Recommended for posterior ETT due to high occlusal forces.

a.Onlays

Preserves more tooth structure than a full crown. Good alternative when there is sufficient ferrule.

b.Full-Coverage Crowns

Gold standard for posterior ETT. Reduces fracture risk but requires more tooth reduction.

c.Endocrowns [7]

Monolithic ceramic restorations bonded into the pulp chamber. Best for molars with limited ferrule.

3. Role of Post and Core [8]

Used when <50% coronal structure remains.

Types of Posts:

1.Metal Posts – Strong but may cause root fractures.

2.Fiber Posts – More flexible and esthetic, recommended for anterior teeth.

4. Clinical Guidelines

Always preserve as much natural tooth structure as possible. Cuspal coverage is recommended for posterior ETT. Use adhesive bonding techniques for fiber posts and composite restorations. Ensure at least 2 mm ferrule for post-supported restorations.

Rationale for the Selection of Dental Materials in Restoring Endodontically Treated Teeth (ETT)

In order to restore endodontically treated teeth (ETT), dental materials must minimise fracture risks while offering strength, durability, aesthetics, and adhesive bonding. The chosen materials should strengthen the remaining tooth structure and improve long-term survival because ETT frequently has decreased moisture content, changed biomechanical properties, and structural loss.

1. Selection Criteria for Dental Materials

- Mechanical Strength → To withstand occlusal forces, especially in posterior teeth.
- Adhesive Bonding Capability → To improve retention without excessive tooth removal.
- Fracture Resistance → To prevent catastrophic failures.
- Esthetics → Particularly for anterior teeth.
- Biocompatibility → To ensure long-term safety and function.

2. Dental Materials for Different Restorative Scenarios

A. Direct Restorations (Composite Resins) [9]

- Indications: Small cavities or anterior ETT with minimal structural loss.

- Material: Resin-based composites (e.g., nanohybrid, microhybrid).

- Advantages:

Conservative, esthetic, and adhesive bonding with dentin hybridization.
Flexural modulus similar to dentin, reducing stress concentration.

- Disadvantages:

Less fracture resistance than indirect restorations.

- Polymerization shrinkage may lead to microleakage.

B. Indirect Restorations (Ceramic, Zirconia, and Hybrid Materials)

1. Ceramic Onlays & Overlays [10]

- Indications: Moderate loss of tooth structure with functional occlusion.

- Material: Lithium disilicate (e.max), leucite-reinforced ceramic.

- Advantages:
 - Excellent esthetics and translucency.
 - Strong adhesive bonding to enamel/dentin.
- Disadvantages:
 - More brittle than zirconia under high occlusal stress.

2. Full-Coverage Crowns (Metal-Ceramic, Lithium Disilicate, Zirconia) [11]

- Indications: Posterior ETT with extensive structural loss.
- Materials:
 - Lithium Disilicate (e.max) → Esthetic + moderate strength.
 - Zirconia → High strength for molars, opaque.
 - Porcelain-Fused-to-Metal (PFM) → Durable but less esthetic.
- Advantages:
 - Superior fracture resistance compared to direct restorations.
 - Protects cusps from fractures.
- Disadvantages:
 - Requires more tooth preparation than onlays.

3. Endocrowns (Monolithic Ceramic Restorations) [12]

Indications: Molars with minimal ferrule and large pulp chambers.

Material: Lithium disilicate (e.max) or Resin-Nanoceramics (e.g., Lava Ultimate).

Advantages:

Bonding within the pulp chamber for better retention.
Conservative alternative to post-core-crown restorations.

Disadvantages:

Less suitable for premolars and anterior teeth.

C. Post and Core Materials [13]

Used when <50% coronal structure remains.

1. Fiber-Reinforced Composite (FRC) Posts

- Material: Carbon or glass fiber-reinforced composite.
- Advantages:
 - More flexible, reducing root fracture risk.
 - Better stress distribution than metal posts.

2. Metal Posts (Titanium, Stainless Steel, Cast Posts) [14]

- Advantages:
 - High strength and durability.
- Disadvantages:
 - Increased root fracture risk due to rigidity.

3. Cementation Materials [15]

Material	Indications	Advantages	Examples
Resin Cement	Adhesive bonding (ceramics, fiber posts)	High bond strength, esthetic	RelyX, Variolink
Glass Ionomer Cement	Metal post-core, PFM crowns	Fluoride release, moisture tolerant	FujiCEM
Self-Adhesive Resin Cement	Zirconia crowns	No need for bonding agents	Panavia SA

The rationale for material selection depends on tooth location, remaining structure, and function.

- Anterior teeth → Composite or lithium disilicate crowns for esthetics.
- Posterior teeth → Zirconia or lithium disilicate crowns for durability.
- Minimal loss → Onlays or overlays to conserve structure.
- Severe loss → Post-core & crown or endocrown for retention.

Rationale for the Selection of Dental Materials for Restoring Endodontically Treated Teeth

Endodontically treated teeth (ETT) are more susceptible to fractures, functional failures, and secondary infections if they are not restored properly because of the removed pulp tissue, dehydration, and loss of tooth structure during caries removal, access cavity preparation, and canal instrumentation. The following goals should guide the choice of dental materials for ETT restoration: Provide long-lasting and biocompatible restorations; Ensure strong bonding to prevent microleakage; Maintain aesthetic and functional integrity.

Biomechanical Considerations in ETT Restoration

A. Biomechanical Weakness of ETT [16]

Key Issues:

1. Loss of Coronal Tooth Structure
 - o Removal of enamel and dentin reduces structural strength
2. Loss of Dentin Moisture Content
 - o ETT have lower water content, leading to increased brittleness
3. Reduced Fracture Resistance

Intact teeth distribute occlusal forces evenly, whereas ETT experience stress concentration in weakened areas

B. Ferrule Effect and Structural Retention [17]

- A ferrule of ≥ 2 mm enhances fracture resistance by distributing occlusal forces around the root structure
- Ferrule improves longevity of crowns and reduces failure rates in post-restored teeth

Rationalization of Dental Materials for ETT Restoration [17]

A. Composite Resins for Direct Restorations

Indications:

- Anterior teeth with minimal structural loss
- Small Class I or Class II restorations in molars

Material Properties:

- Composite resins provide good aesthetics, adhesive bonding, and minimal tooth preparation.
- However, polymerization shrinkage and lower fracture toughness limit their use in heavily loaded areas.

Clinical Implications

Suitable for small restorations and non-load-bearing areas Not ideal for posterior teeth with extensive loss of structure

B. Indirect Restorations (Onlays, Crowns, and Endocrowns)

1. Onlays (Ceramic, Composite, or Hybrid Materials) [18]

Indications: Moderate loss of coronal tooth structure but with intact cusps.

- Lithium disilicate onlays (e.g., IPS e.max) exhibit high strength and bond well to enamel/dentin.
- Resin nanoceramic onlays (e.g., Lava Ultimate) provide shock absorption but have lower wear resistance.

Clinical Implications

Preserve tooth structure while improving fracture resistance Less durable than full-coverage crowns in high-stress areas

2. Full-Coverage Crowns (PFM, Lithium Disilicate, Zirconia)

Indications: Posterior teeth with extensive structural loss or high occlusal loads.

Material Choices: [19]

1. Lithium Disilicate (e.max) – Esthetic, strong, and suitable for anterior or premolar restorations.
2. Zirconia Crowns – Highly fracture-resistant, best for molars with heavy occlusal forces.
3. Porcelain-Fused-to-Metal (PFM) – Long-standing durability, but esthetic limitations.

Clinical Implications:

Cuspal coverage prevents fracture in posterior ETT More invasive preparation compared to onlays

3. Endocrowns [20]

Indications: Molars with large pulp chambers and minimal ferrule.

Material Choices:

- Lithium Disilicate (e.max) → Strong, esthetic, excellent bonding to dentin.
- Hybrid Ceramic (VITA Enamic) → More shock absorption, lower modulus of elasticity.

- ClinicalImplication:
Less invasive than traditional post-core-crown Not suitable for anterior teeth due to functional demands

C. Post and Core Materials for Severely Weakened ETT

1. Fiber-Reinforced Composite (FRC) Posts [21]

- More flexible than metal, reducing root fracture risk.
- Improves stress distribution and enhances aesthetic integration.

ClinicalImplication:

Preferred in aesthetic zones and anterior teeth Not as strong as metal posts for high-load areas

2. Metal Posts (Titanium, Stainless Steel, Cast Posts) [22]

- Provide superior strength but may lead to root fractures due to rigidity.
- Suitable for teeth with severe structural loss and thick dentinal walls.

ClinicalImplication:

Stronger than fiber posts in high-load areas Higher root fracture risk, particularly in thin roots.

Recent advancements in techniques and material selection to restore endodontically treated tooth

Restoring endodontically treated teeth (ETT) has seen significant advancements in both materials and techniques, aiming to enhance the longevity, functionality, and esthetics of these restorations.

1. Adhesive Techniques and Materials: [23]

Recent developments in adhesive dentistry have led to the increased use of composite resins and ceramics for restoring ETT. These materials, combined with advanced bonding agents, offer improved adhesion to tooth structures, resulting in restorations that are both durable and esthetically pleasing. The emphasis on adhesive techniques allows for more conservative preparations, preserving as much natural tooth structure as possible.

2. Fiber-Reinforced Composite (FRC) Posts: [24]

The introduction of fiber posts has provided a favorable alternative to traditional metal posts. Fiber posts are made from composite materials and are used to support restorations in ETT. They offer advantages such as better esthetics and a modulus of elasticity similar to dentin, which helps in distributing occlusal forces more evenly and reducing the risk of root fractures.

3. High-Strength Ceramics: [25]

Advances in ceramic materials, such as lithium disilicate and zirconia, have expanded restorative options for ETT. These high-strength ceramics provide excellent esthetics and durability, making them suitable for crowns, onlays, and endocrowns. Their superior mechanical properties allow for restorations that can withstand occlusal forces while maintaining a natural appearance.

4. Computer-Aided Design and Manufacturing (CAD/CAM): [26]

The integration of CAD/CAM technology in dentistry has revolutionized the fabrication of restorations for ETT. This technology enables precise design and milling of restorations, ensuring a better fit and reducing chair time. Materials such as CAD/CAM-fabricated porcelain have been compared in studies, highlighting their effectiveness in restoring ETT.

5. Bioceramic Materials: [27]

Bioceramics, including materials like mineral trioxide aggregate (MTA) and Biodentine, have been utilized in endodontic procedures for their biocompatibility and sealing properties. These materials are used in various applications, such as root-end fillings and perforation repairs, contributing to the success of endodontic treatments. These advancements reflect a trend towards materials and techniques that not only restore function but also preserve tooth structure and enhance esthetics. Ongoing research and development continue to refine these approaches, offering clinicians a variety of options tailored to individual patient needs.

2. CONCLUSION

The selection of dental materials for restoring endodontically treated teeth (ETT) is a critical decision that directly impacts the longevity, function, and esthetics of the restoration. The rationale for material selection is guided by biomechanical principles, structural considerations, functional demands, and esthetic requirements. Ultimately, the choice of restorative material should be patient-specific, considering factors such as tooth location, occlusal forces, remaining tooth structure, and esthetic expectations. Evidence-based material selection ensures optimal longevity, function, and patient satisfaction, reinforcing the importance of a customized, case-dependent approach in modern prosthodontics.

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