Restoration of the Endodontically Treated Tooth

Pathways of the Pulp, *Cohen* 10th edition
Restoration of the Endodontically Treated Tooth, chapter 22

THIS IS A READING GUIDE FOR THE ASSIGNED REFERENCE

Lecture Outline

- Special features of endodontically treated teeth.
- Restorative materials and options.
- Pretreatment evaluation and treatment strategy.

Special features of endodontically treated teeth

Specific Tissue Modifications and Possible Clinical Implications Following Loss of Vitality or Endodontic Treatment

Alteration Level	Specific Changes	Possible Clinical Implication
Composition	Collagen structure Tooth moisture Mineral composition and content	Increased tooth fragility Reduced adhesion to substrate
Dentin structure	Elasticity modulus and behavior Tensile and shear strength Microhardness	Increased tooth fragility
Tooth macrostructure	Resistance to deformation Resistance to fracture Resistance to fatigue	Increased tooth fragility Reduced retention/ stability of the prosthesis

Special features of endodontically treated teeth

I. Compositional Changes in Nonvital Teeth and Influence of Endodontic Therapy

- **Chelators mainly deplete calcium by complex formation and affect noncollagenous proteins (NCP), leading to dentin erosion and softening.**
- **Sodium hypochlorite demonstrates a proteolytic action by extensive fragmentation of long peptide chains such as collagen.**

Special features of endodontically treated teeth

II. Dentin Structure and Properties in Nonvital and Endodontically Treated Teeth

- No or only minor differences in microhardness values were found between vital and nonvital dentin of contralateral teeth after periods varying from 0.2 to 10 years.
- The chemicals used for canal irrigation and disinfection, as already mentioned, interact with mineral and organic contents and then reduce dentin elasticity and flexural strength to a significant extentas well as microhardness.

Special features of endodontically treated teeth

III. Fracture Resistance and Tooth Stiffness of Nonvital and Endodontically Treated Teeth

- The major changes in tooth biomechanics are attributed to the loss of tissue.
- Endodontic access cavity combined with an MOD preparation results in maximum tooth fragilization.
- Minimal 1-mm ferrule is considered necessary to stabilize the restoration

Special features of endodontically treated teeth

IV. Esthetic Changes in Nonvital and Endodontically Treated Teeth

Restorative Materials and Options

- Restorations of endodontically treated teeth are designed to:

(1) Protect the remaining tooth from fracture
(2) Prevent reinfection of the root canal system
(3) Replace the missing tooth structure

- The selection of appropriate restorative materials and techniques is dictated by the amount of remaining tooth structure.

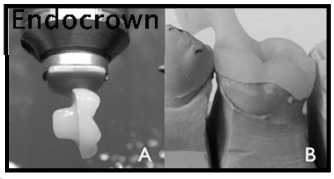
Restorative Materials and Options

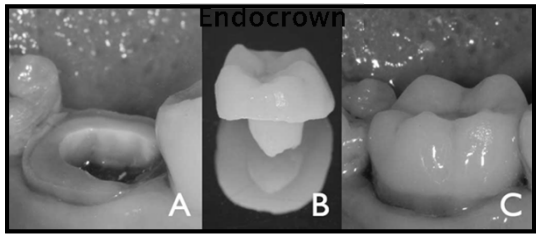
Direct Composite Restorations

- Anterior teeth
- Posterior teeth
- Resistance to fracture of endodontically treated teeth is reduced by 69% in cases where MOD cavities are present

Restorative Materials and Options

Indirect Restorations: Composite or Ceramic Onlays and Overlays and Endocrowns





Restorative Materials and Options

Full Crowns

- When a significant amount of coronal tooth structure has been lost by caries, restorative procedures, and endodontics, a full crown may be the restoration of choice.
- The post, the core, and their luting or bonding agents together form a foundation restoration to support the future crown

Restorative Materials and Options

Full Crowns

- The crown and crown preparation together must meet five requirements:

1. The ferrule (dentin axial wall height) must be at least 2 to 3 mm.
2. The axial walls must be parallel.
3. The restoration must completely encircle the tooth.
4. The margin must be on solid tooth structure.
5. The crown and crown preparation must not invade the attachment apparatus.

Restorative Materials and Options

Full Crowns

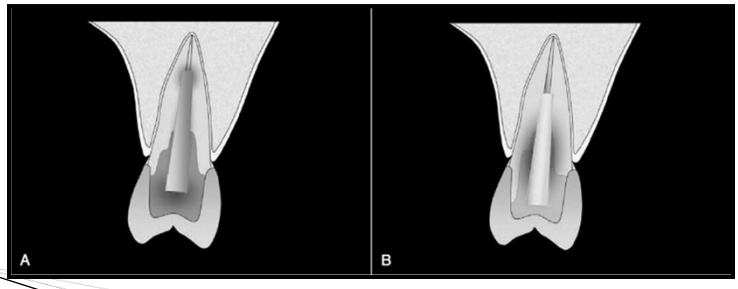
- Root anatomy can also have significant influence over post placement and selection.
- Posts should provide following clinical features :

1. Maximal protection of the root from fracture
2. Maximal retention within the root and retrievability
3. Maximal retention of the core and crown
4. Maximal protection of the crown margin seal from coronal leakage
5. Pleasing esthetics, when indicated
6. High radiographic visibility
7. Biocompatibility

Restorative Materials and Options

Why Roots Fracture

- Because teeth are subjected to fluctuating cycles of loading and unloading during mastication, fatigue failure of dentin, posts, cores, crown margins, or adhesive components are all likely to occur.



Restorative Materials and Options

Direct Foundation Restorations

- When a sufficient amount of tissue is present at the periphery of the prepared tooth, a direct foundation restoration is indicated.
- **Posts**

Posts can be fabricated from metal (gold, titanium, stainless steel), ceramic, or fiber-reinforced resins.

- **Core Materials**

The core replaces carious, fractured, or missing coronal structure and helps to retain the final restoration

Restorative Materials and Options

Direct Foundation Restorations

Posts

- *Prefabricated Metallic Posts*
- *Fiber Posts* (Carbon, glass, silica, or quartz) Bonding fiber posts to root canal dentin can improve the distribution of forces applied along the root
- *Zirconia Posts* (Zirconium dioxide (ZrO_2) partially stabilized with yttrium oxide)

  High flexural strength, esthetic, partially adhesive, very rigid, but also brittle and cannot be etched.

Restorative Materials and Options

Direct Foundation Restorations

Core Materials

Physical characteristics of a core include

1. High compressive and flexural strength
2. Dimensional stability
3. Ease of manipulation
4. Short setting time
5. Ability to bond to both tooth and post.

Restorative Materials and Options

Direct Foundation Restorations

Core Materials

1. ***Composite Resin Core .*** Composite core materials can be used in association with metallic, fiber, or zirconia posts
2. ***Amalgam Core.*** Amalcore, Amalgam can also be used in combination with a prefabricated metallic post.
3. ***Glass Ionomer Core and Modified Glass Ionomer Core***

Restorative Materials and Options

Indirect Foundation Restorations: Cast Post and Core

- The core is an integral extension of the post, and that the core does not depend on mechanical means for retention on the post.
- Valuable tooth structure must be removed to create a path of insertion or withdrawal.
- The procedure is expensive because two appointments are needed, and laboratory costs may be significant.
- The cast post/core system has a higher clinical rate of root fracture than preformed posts.

Restorative Materials and Options

Luting Cements

1. **Zinc phosphate cements or polycarboxylate cements** (Mostly used for cementing metal restorations and posts)
2. ***Glass Ionomer Luting Cements*** (Ease of manipulation, chemical setting, and ability to bond to both tooth and post)
3. **Resin-modified GIC** are not indicated for post cementation, because these cements exhibit hygroscopic expansion

Restorative Materials and Options

Luting Cements

4. ***Resin-Based Luting Cements*** (Require a pretreatment of the root canal dentin with either etch-and-rinse or self-etching adhesives)
5. ***Self-Adhesive Cements*** (Contain multifunctional phosphoric acid methacrylates that react with hydroxyapatite and simultaneously demineralize and infiltrate dental hard tissue)

Pretreatment evaluation and treatment strategy

- *Endodontic Evaluation*

1. Inspection of the quality of existing endodontic treatment
2. Endodontic retreatment is indicated for teeth showing radiographic signs of apical periodontitis or clinical symptoms of inflammation.
3. Canals obturated with a silver cone or other inappropriate filling material should be endodontically retreated before starting any restorative therapy

Pretreatment evaluation and treatment strategy

- *Periodontal Evaluation*

The following conditions are to be considered as critical for treatment success:

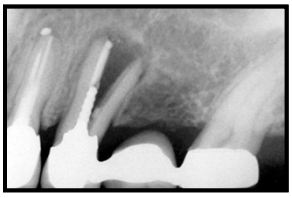
1. Healthy gingival tissue
2. Normal bone architecture and attachment levels to favor periodontal health
3. Maintenance of biologic width and ferrule effect before and after endodontic and restorative phases

Pretreatment evaluation and treatment strategy

- *Biomechanical Evaluation*

Important clinical factors include the following:

1. The amount and quality of remaining tooth structure
2. The anatomic position of the tooth
3. The occlusal forces on the tooth
4. The restorative requirements of the tooth

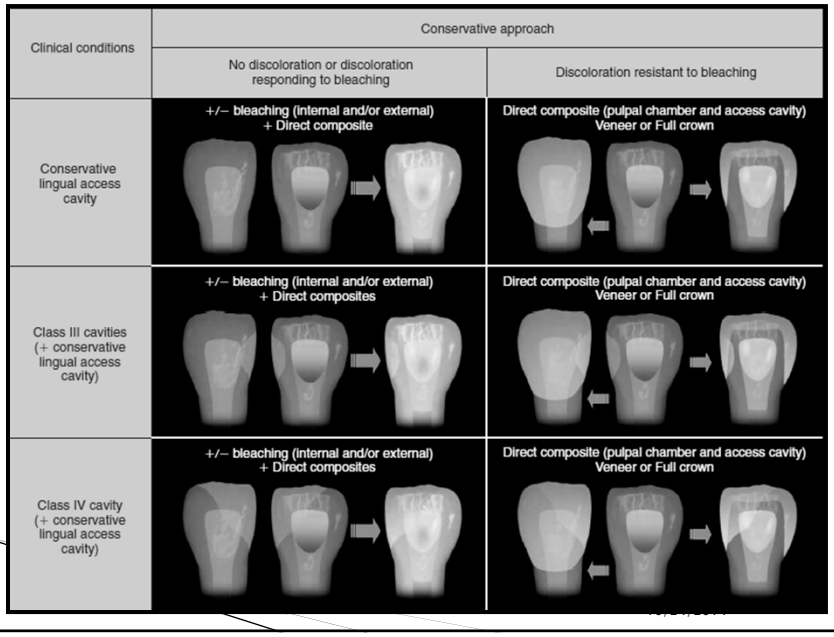


Pretreatment evaluation and treatment strategy

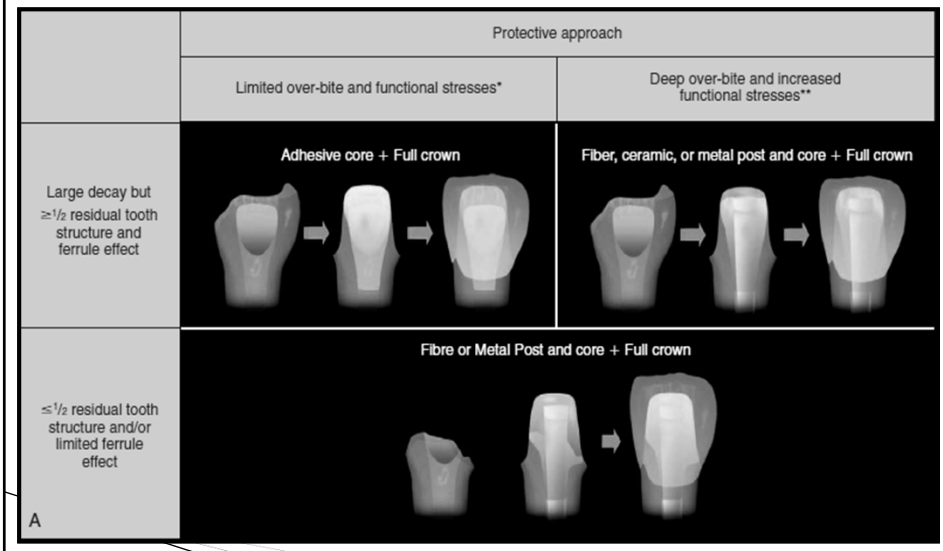
- *Tooth Position, Occlusal Forces, and Parafunctions*
- *Esthetic Evaluation and Requirements*

All teeth located in the esthetic zone also require critical control of endodontic filling materials in the coronal third of the canal and the pulp chamber to avoid or reduce the risk of discoloration.

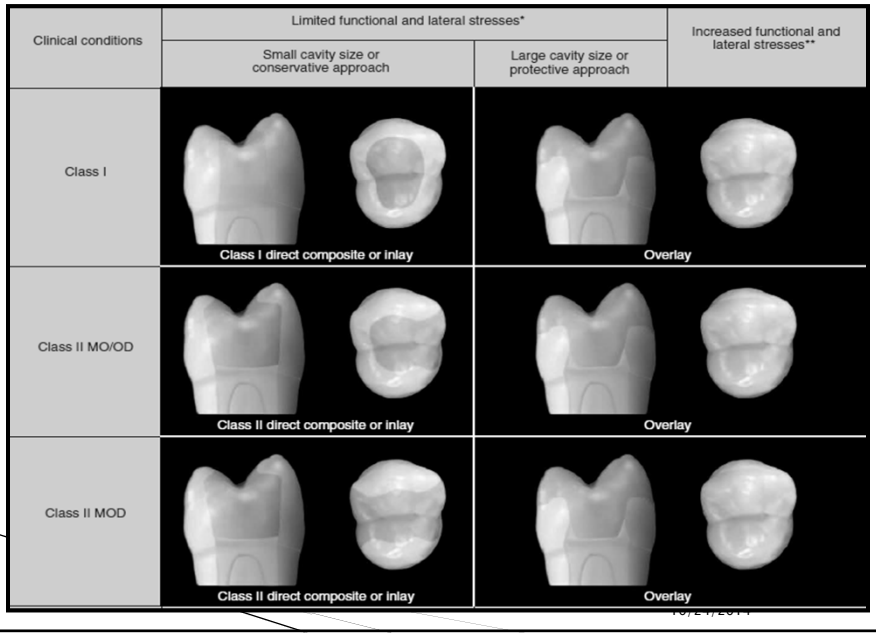
Treatment Strategy



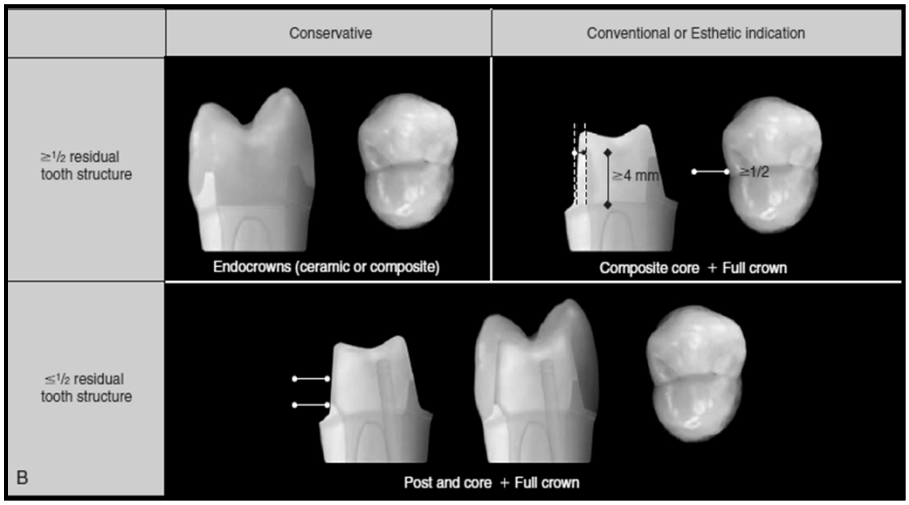
Treatment Strategy



Treatment Strategy



Treatment Strategy



Clinical Protocols for Restoring Nonvital Teeth With Partial Restorations (Most Likely Procedures)

Treatment Approach	Indications	Tooth Preparation (Critical Guidelines)	Interface Treatment		Restoration Fabrication
			Tooth	Restoration	
Composite restoration	Minimal tissue loss	None	DBA	—	Direct multilayer
Veneer	Limited tissue loss	≥1 mm Buccal reduction, lingual enamel present, minimal to moderate discoloration only	DBA	1. Sandblasting or etching 2. Silane 3. Bonding resin	CP direct multilayer *or* *In laboratory:* Etchable CER: fired, pressed, or CAD-CAM
Overlay (composite/ ceramics)	Thin remaining walls	Minimum 2 mm occlusal reduction	DBA + composite lining	1. Sandblasting or etching 2. Silane 3. Bonding resin	*In laboratory:* CP: hand-shaped, light and/or heat cured, CAD-CAM Etchable CER: fired, pressed or CAD-CAM
Endocrown (composite/ ceramics)	Loss of occlusal anatomy	Minimum 2 mm occlusal reduction, extension into pulpal chamber	DBA + composite lining	1. Sandblasting or etching 2. Silane 3. Bonding resin	*In laboratory:* CP: hand-shaped, light and/or heat cured, CAD-CAM Etchable CER: fired, pressed, or CAD-CAM

CAD-CAM, Computer-aided design/computer-aided machined; *CER*, ceramic; *CP*, composite; *DBA*, dentin bonding agent; *Dual*, dual curing; *LC*, light curing; *PFM*, porcelain fused to metal; *SA*, self-adhesive.

Clinical Protocols for Restoring Nonvital Teeth With Full Prosthetic Restorations (Most Likely Procedures)

Treatment Approach	Indications	Tooth Preparation (Critical Guidelines)	Foundation		Restoration	
			Post	Core	Fabrication	Luting
Composite core	Reduced walls but >½ crown height	Maintain all residual structures >1 mm thickness (after core prep.)	—	DBA + composite Dual or LC, incremental	*In laboratory:* PFM or full ceramic restoration: slip-casting, pressed, or CAD-CAM	Coating, sandblasting, or etching + silane and Dual or SA cement
Composite core + ceramic post	More than ½ coronal structure lost, reduced wall height	Maintain all residual structures >1 mm thickness (after core prep.)	Sandblasting or coating/silane + DBA + Dual cement or SA cement	DBA + composite Dual or LC, incremental	*In laboratory:* PFM or full ceramic restoration: slip-casting, pressed, or CAD-CAM	Coating, sandblasting, or etching + silane and Dual or SA cement
Composite core + in vitro fiber post	More than ½ coronal structure lost, reduced wall height	Maintain all residual structures >1 mm thickness (after core prep.)	Sandblasting or coating/silane + DBA + Dual cement or SA cement	DBA + composite Dual or LC, incremental	*In laboratory:* PFM or full ceramic restoration: slip-casting, pressed, or CAD-CAM	Coating, sandblasting, or etching + silane and Dual or SA cement
Composite core + metal post	More than ⅔ coronal structure lost, reduced wall height	Maintain all residual structures >1 mm thickness (after core prep.)	Sandblasting or coating/silane + DBA + Dual cement or SA cement	DBA + composite Dual or LC, incremental	*In laboratory:* PFM or full ceramic restoration: slip-casting, pressed, or CAD-CAM	Coating, sandblasting, or etching + silane and Dual or SA cement
Amalgam core (+/– metal post)	Alternative to composite core with metal post	Maintain all residual structures >1 mm thickness (after core prep.)	No tt + nonadhesive cement or sandblasting/ coating/silane + DBA + Dual cement or SA cement	Amalgam placement in retentive cavity/ preparation	*In laboratory:* PFM restoration	Coating, sandblasting, or etching + silane and Dual or SA cement
Cast gold post and core (+/– porcelain)	More than 3/4 coronal structure lost	Maintain all residual structures >1 mm thickness (after core prep.) Internal walls are divergent	No tt/sandblasting + nonadhesive cement or sandblasting/ coating/silane + DBA + Dual cement or SA cement	No tt + nonadhesive cement or DBA + Dual cement or SA cement	*In laboratory:* PFM or full ceramic restoration: Zirconia/ CAD-CAM	Coating, sandblasting, or etching + silane and Dual or SA cement

CAD-CAM, Computer-aided design/computer-aided machined; *CER*, ceramic; *CP*, composite; *DBA*, dentin bonding agent; *Dual*, dual curing; *LC*, light curing; *PFM*, porcelain fused to metal; *SA*, self-adhesive.

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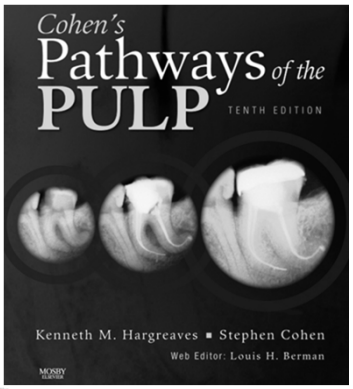

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