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Restoration of endodontically treated teeth

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Restoration of endodontically treated teeth

Abstract

Teeth requiring endodontic treatment need to be assessed restoratively prior to initiating endodontic care. Endodontic treatment requires initial access to the pulp chamber and canals to be carried out appropriately. Canals can be identified, instrumented, and obturated, but if the tooth cannot be predictably restored, clinical success is guarded. Although adhesive restorations have improved compared to what has been historically available, adequate ferrule and posts may still be required from an engineering standpoint depending on what remains of the native tooth structure to prevent dislodgement of the restoration from the native tooth structure.

This course will review engineering principles to allow the restorative dentist to:

- predictably restore endodontically treated teeth,
- design an endodontic access that preserves as much sound tooth structure as possible,
- assess the restorability of a tooth before endodontic treatment, and
- improve treatment success.

Educational objectives

1. Understand that conservative treatment starts with endodontic access.
2. Learn how teeth are restored based on how much native tooth structure remains.
3. Know when, why, and how to use posts to restore endodontically treated teeth.
4. Understand restorative ferrule, and when and how much is necessary.

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Introduction

Adhesive dentistry has improved the quality and longevity of restorative treatment. Yet longstanding principles are still valid and are especially true for restoring endodontically treated teeth. The long-term prognosis is increased when we approach the tooth from an engineering perspective. Unfortunately, those engineering principles may be ignored due to the opinion that "bonding holds it all together." Thus, clinical success suffers.

Teeth requiring endodontic treatment usually have existing restorative materials (amalgam or composite), crowns, or recurrent decay. Although teeth without existing restorations requiring endodontic treatment are atypical, they might require endodontic intervention related to trauma or periodontal issues. Endodontic access and excavation of the decay can further weaken the remaining tooth, so reconstruction requires reinforcement of the tooth to function under normal loading.[1]

As restorative practitioners, whether we render endodontic treatment or refer to a specialist, one first determines the restorability of the tooth. After removal of all existing restorative material and decay:

- Can one determine if sufficient tooth structure is present to allow placement of adequate ferrule for a crown?
- Will crown preparation leave insufficient tooth structure to support that crown?
- Would an onlay be a better restoration, allowing more tooth structure preservation?
- Are posts needed to aid in retention of the core?

The need for restoration is determined by how much native tooth structure remains. The goal of conservative dentistry is native tooth structure preservation.[2] These conservative treatment goals also extend to endodontics during access and instrumentation.[3] The literature demonstrates that long-term treatment success correlates with how much native tooth structure is preserved.[1,4] Therefore, evaluation before treatment is key to long-term predictability of teeth that require endodontics.

The endodontic component

The elimination of all dental caries is the accepted goal of endodontic and restorative treatment. This is especially true for endodontically treated teeth because residual caries might cause coronal leakage of the canal system leading to endodontic failure. Additionally, remaining caries undermine tooth structure, and in the presence of cariogenic bacteria and carbohydrate substrate, dental caries may progress, leading to structural tooth failure. However, removal of caries should be performed carefully to preserve as much sound tooth structure as feasible, facilitating restorative options.

Conservative treatment begins with understanding the tooth's anatomy and the locations of the canal orifices on the floor of the pulp chamber. This allows for the preservation of tooth structure when locating and accessing the canals.[5] The first step is removal of old restorative materials and decay. After excavation of restorative materials and caries, only the necessary tooth structure required to unroof the pulp chamber and locate the canal orifices requires removal. Such a process preserves the important native tooth structure that contributes to long-term survival of the tooth.

Teeth with existing crowns can be challenging

Teeth with previous crown preparation present challenges during endodontic access. The practitioner may lose anatomical references with regard to the location of the pulp chamber within the tooth. This is particularly true with posterior teeth. A crown preparation can obscure the initial tooth position relative to the other teeth in the arch, e.g., rotation or tipping of a tooth prior to crown placement. In such cases, the position of the pulp chamber and canal orifices might align with the anatomy of the prosthetic crown.

Because the crown often requires replacement after endodontic treatment, removal of most of the occlusal aspects of the crown to expose the underlying tooth structure improves visibility to unroof the pulp chamber. Occlusal access to initially expose the pulp chamber can reduce the risk for perforation during the process of identification of canal orifices through a narrow access area. If any core material is present under the crown, its careful removal improves visibility and avoids inadvertent straying when trying to unroof the pulp chamber.

The importance of cervical tooth structure

When loaded, teeth under function have force directed in the long axis in posterior teeth. Yet, chewing has an "envelope of function," so laterally directed forces occur on these teeth as well. Due to the angulation to the opposing teeth (tipped facially with contact on the lingual aspect of the tooth), maxillary incisors have loads that are off-axis to the tooth's long axis. Therefore, these forces concentrate at the cervical of the tooth (figure 1).[6] Teeth with weakened cervical regions have a higher failure rate and manage those loads under function less ideally than teeth with intact cervical areas. Maintenance of as much native sound tooth structure in the important cervical region of the tooth is critical to its long-term survival.

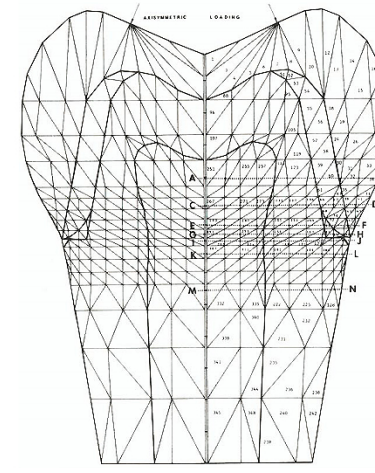

FIGURE 1: Stress concentration under loading with higher levels as the lines get closer together (Image courtesy of Dr. Gene McCoy)

Use of wider taper files (0.08–0.12 or greater) can result in overinstrumentation of the canals by removing greater amounts of cervical tooth structure than required for pulpectomy. Selection of the ideal taper should be dependent on the tooth type involved as well as the cervical size of the canal before treatment. A 0.06-taper file

is well suited in most cases for treating palatal canals of maxillary molars, distal canals of mandibular molars, maxillary central incisors, and all canines. In all other canals, typically instrumentation is effective with a 0.04-taper file.[7] With some exceptions, wider taper files are for those rare clinical circumstances when a radiograph notes a wide canal during diagnosis (figure 2).

Core buildups and posts: Are posts still necessary?

Upon completion of endodontic treatment, the core region of the tooth requires restoration to replace tooth structure removed before treatment to access the canal system and removal of old restorative material and decay. The reconstruction method depends on how much native tooth structure remains.[8]

Posterior teeth, when functionally loaded, undergo minute cuspal spread. This increases when the center of the occlusal surface is prepared for a direct restoration. The wider the volume of missing native tooth structure, the more the cusps might flex away from one another under loading (figure 3). Occlusal tooth structure has a limiting influence on the magnitude of cuspal flexure possible.[9]

Cuspal flexure has fracture implications

The degree of cuspal flexure has important consequences for potential fracture of the coronal aspects of the tooth.[10] When the mesial and distal marginal ridges are intact and not replaced by direct restorative material or undermined by decay, cuspal flexure is limited and acts as a brace for the cusps. When one or both marginal ridges are missing and replaced by restorative material, cuspal flexure increases.[11]

A dramatic increase in cuspal deflection occurs under loading.[12] Such cuspal deflection increases the potential for cuspal fracture under repetitive loading over time. This is of particular concern if the cusps do not limit flexure potential, either with a full-coverage crown or onlay (with "shoed" cusps, overlapped on the buccal or lingual) (figure 4).

Premolars have a narrower mesial-distal dimension than molars and are more prone to cuspal fracture when the marginal ridges are not native tooth structure.[13,14] This fracture potential increases further in endodontically treated premolar teeth because the dentin found in the roof of the intact chamber is missing. This permits greater microflexure of the cusps when loaded (figure 5).[15,16]

After endodontic treatment, when both marginal ridges are intact and only the endodontic access removes native tooth structure, or a limited occlusal restoration is present, an adhesive composite can be used to restore a premolar in these instances (figures 6, 7). In the case of premolars with intact marginal ridges, the teeth can be treated by removal of the obturation material to the canal orifice or several millimeters apical to the canal orifice, and followed by an adhesively bonded composite restoration. It should be noted that preparation that is deeper than 6 mm does not permit adequate intensity from the curing light to complete polymerization of the resin.[17]

In cases where the preparation is too deep to allow for light-cured composite, the recommendation is to use a dual-cure resin to ensure complete curing of the resin at its deepest. Alternatively, the practitioner may use an adhesive that is either self-curing or has a dual-cure promoter, because the curing light might not reach the depth of the preparation. If only light-cured materials are used, this can leave uncured adhesive that limits the bond of the overlaying composite to the remaining dentin. Since self-cure and dual-cure composites are often less translucent when set, esthetics may be improved by overlaying the final 2 mm with a light-curable composite.

When one marginal ridge is intact and the other is missing, an indirect restoration, full-coverage crown, and/or onlay restoration limits cuspal flexure (figure 8). When the missing tooth structure

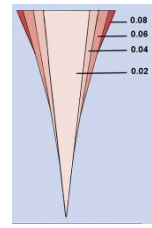

FIGURE 2: Comparison of the amount of cervical tooth structure that would be removed with files of increasing taper

FIGURE 3: Endodontically treated tooth that is restored with composite that has suffered a cuspal fracture under function

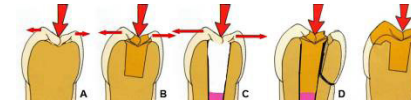

FIGURE 4: Cuspal flexure occurs when the tooth is loaded (A). Greater flexure occurs when the tooth is restored with an occlusal restoration but has not been endodontically treated (B). When endodontics has occurred, even greater cuspal flexure is possible (C). Cuspal flexure may lead to cuspal fracture after restoration with no cuspal shoeing (D). With cuspal shoeing, flexure is prevented and fracture potential is diminished (E).

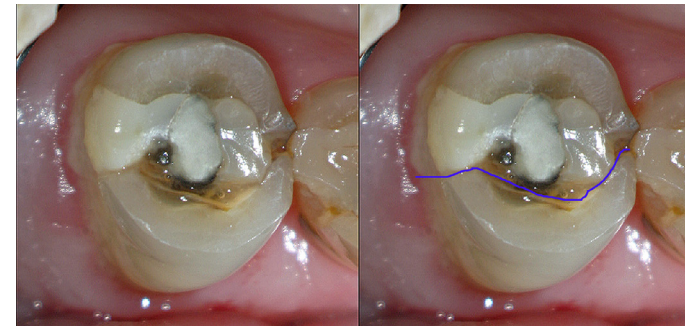

FIGURE 5: An endodontically treated premolar missing both marginal ridges that had a cuspal fracture due to cuspal flexure under function

FIGURE 6: Premolar after endodontic treatment with both marginal ridges intact

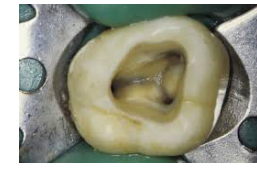

FIGURE 7: Molar after endodontic treatment with both marginal ridges intact

FIGURE 8: Posterior tooth after endodontic treatment with a marginal ridge missing

FIGURE 9: Endodontically treated premolar that has lost both marginal ridges with greater than one-third of the occlusal width missing is subject to greater cuspal flexure under loading once restored with a direct restoration.

at the center of the occlusal surface is less than one-third of the buccal-lingual width of the tooth, an onlay can restore the tooth.[18] An onlay provides cuspal shoeing that limits flexure and potential cuspal fracture.

In the author's opinion, inlay restorations, such as direct resin restorations, do not restrict cuspal flexure and avoidance prevents cuspal fracture or crack propagation, which potentially leads to vertical root fracture. Therefore, when greater than one-third of the occlusal width is missing, or both marginal ridges are not native tooth structure, a full-coverage crown is the best restoration (figure 9). In these situations, typically a post must retain the core because minimal tooth structure is present after preparation for a crown.[19]

The practitioner might view the tooth as having sufficient tooth structure so that a post is not required (figure 10). But the remaining native tooth structure lies on the buccal and lingual of the tooth, and most of this is removed when crown preparation is performed.

Posts aid core buildup retention, but do not strengthen the remaining root. Using posts is dependent on how much tooth structure remains after endodontic treatment and removal of existing decay and restorative material.[11]

FIGURE 10: At left, endodontically treated tooth with native tooth remaining coronally that would yield minimal tooth to support a core buildup and crown once prepared for the crown, illustrated in yellow at right.

Is a post needed in every endodontically treated tooth?

A post can prevent failure of the interface between the core material and tooth structure, but during preparation for its placement, the post should conserve tooth structure and not weaken the tooth. Therefore, a post should:

- equal the diameter of the instrumented canal in the coronal of the root,
- not remove additional tooth structure, and
- act as a locking mechanism for the core to the remaining tooth structure.

When compared to parallel posts, tapered posts also conserve tooth structure. This is especially true in the mid-root area where the post ends and the root anatomy narrows (figure 11). Reducing the root width related to post preparation in the apical portion of the post might lead to horizontal fracture at the post's terminus if occlusal overloading occurs with off-axis repetitive loading.

The purpose of the post is to aid in retention of the core to the tooth. Regarding multicanal teeth, placement of a post into each canal better locks the core to the remaining tooth structure over time under function while decreasing the potential for core dislodgement (figures 12, 13).

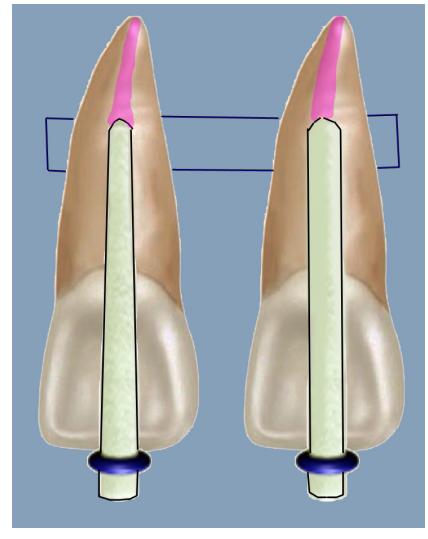

FIGURE 11: At left, comparison of a taper post and parallel post. At right, the amount of root thickness in the apical zone where the root tapers.

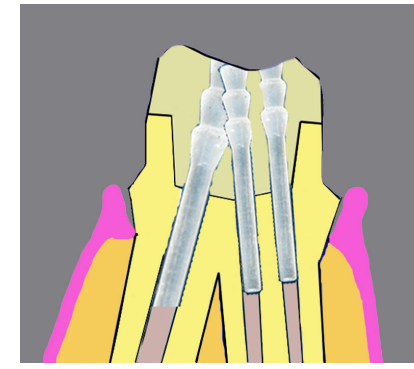

FIGURE 12: Illustrating posts in an endodontically treated molar to pin the core to the remaining tooth structure

FIGURE 13: Clinical case showing posts placed into each canal in an endodontically treated molar to pin the core to the remaining tooth structure

Length of the post is determined by the position of the crestal bone in relation to the root length. The post should extend at least 5 mm apical to the crestal bone, so that in load, a fulcrum does not occur to produce stress concentration at the post's terminus within the tooth, which might lead to root fracture (figure 14). When the post's terminus is close to the crestal bone level, the tooth has more potential flexure with the post's tip acting as a fulcrum point.

Additionally, maintaining at least 5 mm of apical obturation material is important to ensure an apical seal to the canal system, and to prevent future leakage and subsequent failure of the endodontics. After post preparation and before luting the post, a radiograph verifies that the apical obturation was not dislodged during the post preparation.

If sufficient tooth structure is present to achieve at least a 2 mm ferrule effect circumferentially in a posterior tooth, a restoration needs no post. In this situation, alternative retentive elements can retain the core. These include potholes and pins, which are placed interior to the

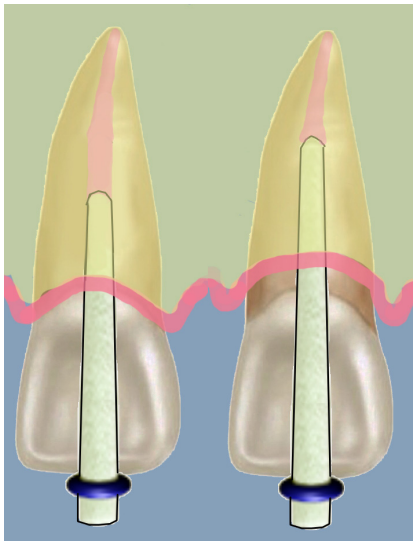

FIGURE 14: Necessary post length relates to the position of the crestal bone. The terminus of the post should extend at least 5 mm apical to the crestal bone (maintaining at least 5 mm of apical obturation) so that when the tooth is loaded, the portion of post apical to the crest doesn't fulcrum and cause a root fracture.

cementoenamel junction (CEJ) so that upon crown preparation, they remain surrounded by tooth structure. When these are used, obturation material is also removed to a depth of 3 mm to 5 mm from the canal orifice to aid locking the core to the tooth, both in the interior and exterior (figure 15).

Anterior teeth, with their narrower cervical cross section, frequently require a post after endodontic treatment.[20] Maxillary anterior teeth, particularly laterals and centrals, are under greater off-axis loading due to contact in the cervical half of the lingual combined with buccally directed occlusal forces. Such teeth can be more prone to crown failure by fracture of the tooth at the crown margin. With adhesively bonded fiber posts and a taper post that is the diameter of the instrumented canal, a better reinforced cervical region on the tooth could improve longevity by decreasing the potential for fracture in this region.[21,22]

Lute material dependent on post type

The material used to lute the post into the root is dependent on the type of post. A luting material that works with metallic posts may not be appropriate for fiber posts. A universal recommendation is that fiber posts require luting with a resin material because these can bond to the post's surface.

Glass ionomer cements do not provide sufficient adhesion between the cement and post to prevent disruption of the interface under function.[23] Glass ionomer cements do not provide adequate pull-out strength of the post from the tooth and might lead to restorative failure over time. Evidence shows that resin cements provide twice the pull-out strength of glass ionomers.[24] Thus, the recommendation is to use a resin cement when placing a fiber post.

The choice then becomes whether to use a resin cement that requires a separate dentin adhesive or a self-etch, self-adhesive resin cement. A light-curing adhesive will most likely not allow curing of the adhesive at the apical portion of the post prep due to depth.

If a dentin adhesive is used in combination with the resin cement, select a self-curing adhesive or an adhesive that can accept the addition of a self-curing promoter before placement into the prepared post space. This leads to lower adhesion of the post along its length as a curing light cannot penetrate beyond 3 mm of the top of the post, so use of a self-cure or dual-cure adhesive will ensure the adhesive will fully cure along the entire post length.[25]

Practitioners should use a microbrush to apply the adhesive in the post space. Then they can immediately fill the post space with resin cement. Next, they should insert the post to the depth of the previously prepared post preparation.

Use of a self-cure, self-adhesive resin cement simplifies the procedure, making luting of the post less technique sensitive.[26] Bond strengths of self-cure, self-adhesive resin cements are comparable to resin cements that require a separate adhesive and demonstrate greater strengths than glass ionomer cements.[27]

The importance of a restorative ferrule

The definition of a restorative ferrule is a band of natural tooth structure between the crown margin and the occlusal aspect of the tooth before any core material begins (figure 16). Although adhesive dentistry has greatly improved in the past 30-plus years, and higher bond strengths to dentin are reported in the literature, the use of basic restorative engineering concepts, such as ferrules, is still important today.[28]

Ferrule is also important on teeth receiving a crown but that have not undergone endodontics. Failure might result, no matter how high the dentin bond strengths of the materials used, when a ferrule of adequate height is not provided. Crown dislodgement and failure can occur (figure 17). Even when a post is present, dislodgement of the restoration can occur related to off-axis loading and lead to separation of the crown with attached post/core from the root (figure 18).

When a crown is off-axis loaded, tension occurs at the crown margin on the side from which the load is directed, and compression occurs on the opposing side (figure 19). An inadequate ferrule can lead to breakdown of the luting of the crown to the tooth, causing an open margin on the tension side. This allows dental caries to begin in this area. Often such tooth decay is difficult to identify, and the patient may

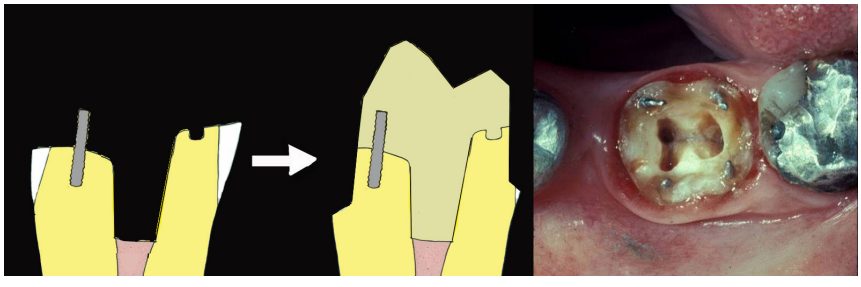

FIGURE 15: Use of pins and potholes, in combination with removal of coronal core obturation material to retain the core to be placed, is an alternative to posts when sufficient tooth is present to achieve a ferrule of at least 2 mm.

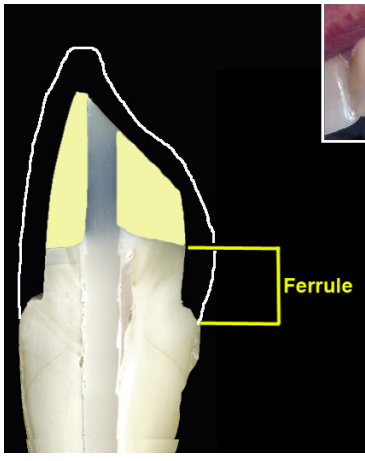

FIGURE 16: The ferrule is the band of natural tooth structure between the restorative margin and the top of the dentin before any core material begins.

FIGURE 17: Insufficient ferrule and lack of a post results in failure of the crown under functional loading over time.

FIGURE 18: Crown failure resulting from inadequate ferrule

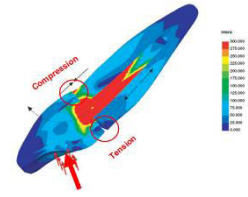

FIGURE 19: When a crown loads in an off-axis direction, tension results at the margin on the side of the load and compression at the margin on the opposite side, which can result in margin opening and recurrent decay when an inadequate ferrule is present. Additionally, stress concentrates cervically (red), which can result in fracture of the core or post and core. (Ichim I, Kuzmanovic DV, Love RM)

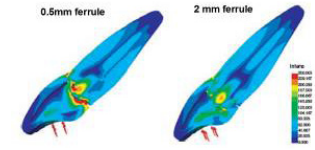

FIGURE 20: Comparison of a minimal ferrule (0.5 mm) and adequate ferrule (2.0 mm) and where and how much stress is present when off-axis loaded. (Red = high stress, dark blue = low stress) (Ichim I, Kuzmanovic DV, Love RM)

not be aware of marginal leakage and decay. Oftentimes, decay is only identified during a recall examination. Since the patient has no perception of sensitivity in the endodontically treated tooth, this decay can progress until the crown dislodges from the tooth or decay becomes visible. Fatigue loading of crowns leads to preliminary leakage failure between the restoration and tooth that is clinically undetectable.[29]

In those cases where minimal or no ferrule is present, stress concentrates under loading at the cervical, which might lead to failure of the core. Metal posts—either cast or prefabricated—are stiffer than the tooth (higher modulus of elasticity). Repetitive loading when a cast or prefabricated post is present potentially leads these higher stresses to vertical root fracture and loss of the tooth. When a metallic post dislodges from a tooth with a crown, the practitioner should check for radial cracks (spokelike) from the post hole, which would indicate the tooth has failed.[30,31]

How much ferrule is needed?

Studies demonstrate that when ferrules of 0.5 mm and 1.0 mm are present, these teeth fail at a significantly lower number of cycles than the 1.5 mm and 2.0 mm ferrules and control teeth.[32,33] Therefore, the recommendation is that a ferrule of 2.0 mm is adequate to resist loading forces that might lead to failure of the restoration or tooth. Another study confirms that a ferrule increases the mechanical resistance of the restoration.[34,35]

When an adequate ferrule is present, one notices less cervical stress (lower magnitude), and the loading forces do not concentrate at the crown margins (figure 20). Those teeth with minimal ferrules see a higher magnitude of stress cervically and at the crown's margins, which increases failure potential of either the restoration or the tooth itself.

Off-axis loading, as previously discussed, is found normally in the posterior and anterior under function. This is potentially more problematic in the maxillary anterior because occlusal contact is off-axis. When insufficient ferrule is present to resist off-axis loading, leakage at the restorative margin occurs first as the restorative failure progresses.[17] The leakage occurs on the side of the tooth that is under tension. In endodontically treated teeth, this is often undetectable until the crown dislodges, or clinically detectable decay presents.

Conclusion

When approaching restoration of endodontically treated teeth, conserving tooth structure is key to improving the longevity of the tooth and its subsequent restoration. This is most critical in the cervical region of the tooth because this is where stress concentrates under repetitive loading.

The process begins with conservative instrumentation during the endodontic treatment to maintain cervical tooth structure. Determination of the type of restorative treatment is based on how much native tooth structure remains.

Consider using a post when less than adequate tooth structure will remain after preparation for a crown. Ferrules are still important to manage off-axis loading that may lead to restorative failure, or—in a worst-case scenario—total failure of the tooth itself.

Few teeth fail due to overengineering, but many fail due to underengineering.

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Notes

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QUESTIONS

1. Teeth requiring endodontic treatment typically have:
   A. Existing restorations
   B. Absence of decay
   C. Cracks and fractures
   D. All of the above

2. Regarding endodontic access, it may:
   A. Be guided by existing restorative materials
   B. Weaken the remaining tooth
   C. Determine how the tooth is restored
   D. All of the above

3. The practitioner needs to determine before initiation of endodontic treatment:
   A. Restorability of the tooth
   B. If the tooth should be splinted to adjacent teeth
   C. Osseous support of the tooth
   D. A and C

4. Long-term success of endodontically treated teeth correlates with:
   A. Obturation material used during endodontics
   B. Obturation technique used during endodontics
   C. How much native tooth structure is present before endodontic treatment
   D. How much native tooth structure is present after endodontic treatment

5. The treatment goal of endodontics and restorative is:
   A. Elimination of any decay around the restoration's margins
   B. Elimination of most decay
   C. Elimination of all decay
   D. Elimination of only visible decay

6. When performing endodontic treatment on a tooth with an existing crown, you should:
   A. Make the access wide enough through the crown to better visualize the tooth below.
   B. Limit access size.
   C. Preserve any existing core material.
   D. Remove the crown before initiating endodontic treatment.

7. With an existing crown, endodontic treatment of a molar can be challenging because:
   A. Tooth may have been rotated.
   B. Tooth may have been tipped.
   C. Tooth anatomy may be different than the crown anatomy.
   D. All of the above

8. During function, stress concentrates on which part of the tooth?
   A. Occlusal
   B. Coronal
   C. Cervical
   D. Root

9. Maxillary anterior teeth under function have the lingual cervical under:
   A. Axial directed load
   B. Tension
   C. Compression
   D. All of the above

10. When comparing different taper endodontic files, greater taper files:
    A. Are less efficient at instrumentation
    B. Are more efficient at instrumentation
    C. Remove more tooth structure in the cervical
    D. Remove less tooth structure in the cervical

11. Ideal file taper selection should be based on:
    A. Length of the root
    B. Whether it exceeds a 0.04 taper
    C. Which tooth or root is instrumented
    D. Whether a post will be used

12. A tooth with a weakened cervical region:
    A. Will see no difference in load management
    B. Should not be treated endodontically
    C. Will be easier to treat
    D. Will have a higher failure rate

13. Which taper file typically is used in the palatal canals of maxillary molars and distal canals of mandibular molars?
    A. 0.02
    B. 0.04
    C. 0.06
    D. 0.08

14. In mandibular incisors, which taper file typically is used?
    A. 0.02
    B. 0.04
    C. 0.06
    D. 0.08

15. The goal of endodontic instrumentation is:
    A. Preservation of cervical tooth structure
    B. To provide a shape that can be obturated
    C. Removal of pulpal debris and affected dentin in the canal system
    D. All of the above

16. Under function, posterior teeth undergo:
    A. More cuspal flexure after endodontic treatment
    B. Less cuspal flexure after endodontic treatment
    C. Less loading after endodontic treatment compared to untreated
    D. No difference in cuspal flexure after endodontic treatment compared to untreated

17. Occlusal tooth structure has a limiting influence on:
    A. The degree of cuspal flexure
    B. Chewing ability
    C. The magnitude of cuspal flexure possible
    D. A and C

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QUESTIONS

18. In a posterior tooth, what factor has the most cuspal flexure limiting influence?
    A. Type of restorative material filling in the tooth
    B. Presence of both marginal ridges in native tooth structure
    C. Presence of one marginal ridge in native tooth structure
    D. How well bonded the filling material is in the tooth

19. With a missing marginal ridge in an endodontically treated tooth, an inlay restoration:
    A. Is a lower cost alternative to a full-coverage crown
    B. Is an acceptable alternative to a full-coverage crown
    C. Is avoided because it does not limit cuspal flexure
    D. Is considered because it preserves more tooth structure

20. When an onlay is used for restoration of an endodontically treated tooth, then:
    A. The cusps should be shoed to limit cuspal flexure.
    B. The occlusal margin on a maxillary molar on the palatal cusps should terminate buccal to the cusp tips.
    C. The occlusal margin on a maxillary molar on the buccal cusps should terminate lingual to the cusp tips.
    D. Cast gold is preferred to a ceramic material.

21. When restoring an endodontically treated posterior tooth with both marginal ridges intact and limited tooth missing, which restoration would be best?
    A. Direct-bonded composite
    B. Lab-fabricated inlay
    C. Lab-fabricated onlay
    D. Full-coverage crown

22. Dimensionally, which tooth may be more prone to cuspal fracture?
    A. Anterior teeth
    B. Premolars
    C. Maxillary molars
    D. Mandibular molars

23. The purpose of a post is to:
    A. Strengthen the root
    B. Allow higher loading of the tooth under function
    C. Improve the esthetics of the restoration
    D. Aid in retention of the core

24. When placing a post, which shape is recommended?
    A. Active type
    B. Taper
    C. Parallel post
    D. Shape doesn't have any influence

25. Post usage in a maxillary incisor is:
    A. Rarely indicated
    B. Contraindicated because it increases tooth fracture
    C. Due to compromising esthetics without a post ever indicated
    D. Indicated because occlusal contact is off-axis in the cervical half of the tooth

26. Apical termination of the post is determined by the:
    A. Crestal bone level
    B. Diameter of the root
    C. Height of the coronal aspect of the tooth
    D. Type of material from which the post is fabricated

27. To aid in core retention, the following may also be used:
    A. Removal of obturation material apical to the canal orifice
    B. Potholes
    C. Pins
    D. All of the above

28. When luting a fiber post, the best cement is:
    A. Any cement
    B. Glass ionomer
    C. Resin cement
    D. Zinc phosphate

29. The minimum ferrule height should be at least:
    A. 0.5 mm
    B. 1.0 mm
    C. 1.5 mm
    D. 2.0 mm

30. Marginal leakage resulting from an insufficient ferrule may be:
    A. Acceptable with good patient hygiene
    B. Avoided by bonding the crown to the remaining tooth
    C. Difficult to detect clinically until it has progressed
    D. Avoided with the use of ceramic crowns

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Restoration of endodontically treated teeth

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1. Understand that conservative treatment starts with endodontic access.
2. Learn how teeth are restored based on how much native tooth structure remains.
3. Know when, why, and how to use posts to restore endodontically treated teeth.
4. Understand restorative ferrule, and when and how much is necessary.

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5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
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10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
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12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
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