Restoration of endodontically treated teeth: A guide for the restorative dentist

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Abstract
This article provides a decision flowchart that can serve as a guide to selecting the optimum restorations for endodontically treated teeth. The process begins with an assessment of the endodontically treated tooth to determine its restorability. The restorable tooth is then evaluated for the amount of remaining coronal tooth structure. Anterior teeth with minimal or moderate coronal damage do not require complete coverage or a post and core. However, anterior teeth with significant coronal damage will require complete coverage plus a post and core. Posterior teeth with minimal coronal damage may be treated conservatively with partial-coverage restorations. For posterior teeth with moderate damage and those with curved roots, amalgam or resin composite foundations are used to support complete-coverage restorations. Posterior teeth with significant coronal damage require a post and core and a complete-coverage restoration. (Quintessence Int 1997;28:457-462.)

Clinical relevance
This article provides a practical decision guide to the restoration of endodontically treated teeth based on the amount of sound tooth structure remaining. This guide is designed to ensure that restorations are placed on restorable teeth only and that the teeth receive the treatment necessary to best restore function and esthetics.

Introduction
The purpose of this article is to present a decision flow chart based on current prosthodontic principles that provides the restorative dentist with an understandable, universal, and reliable guide to restoring endodontically treated teeth.

Historically, the restoration of endodontically treated teeth has been an empirical exercise,1 the results of which are not always predictable. Many restorative dentists base their decision-making process on past clinical experience rather than follow a specific protocol. However, in recent years, restorative dentists have benefited from technological advances in endodontics, periodontics, and restorative techniques and protocols. It is possible to provide a more reliable approach to decision making, resulting in more predictable restorative results. Teeth that would otherwise be lost are endodontically treated and restored to occlusal function, preserving the stability of the dental arches and improving esthetics.2 Additionally, endodontically treated teeth have demonstrated clinical success over time as fixed partial denture (FPD) and removable partial denture (RPD) abutments.3

Conventional endodontic therapy is reported to have a success rate of up to 95%.4 However, this is not an assessment of complete therapy for the tooth. The final result of endodontic treatment is dependent on the appropriate and timely coronal restoration of the endodontically treated tooth.5 Studies have reported that the failure to properly restore the endodontically treated tooth is a primary cause of endodontic failure.5,6 Unrestored endodontically treated teeth are especially susceptible to fracture and bacterial contamination.7
Vire\(^8\) found that 60\% of 116 extracted endodontically treated teeth had failed because of inadequate restoration. Bishop and Biggs\(^9\) confirmed the need for timely restoration immediately following completion of endodontic therapy to protect the treated tooth from microbial contamination.\(^6,8\)

The strength of an endodontically treated tooth is reported to be directly related to the bulk of the remaining dentin.\(^10-12\) It follows that the intact natural crown of an endodontically treated tooth provides the best chance for long-term success; however, this condition seldom exists. In most endodontically treated teeth the amount of coronal tooth structure remaining is limited, as a result of trauma, caries, prior restorations, and endodontic access procedures.\(^11-12\)

The conventional and widespread belief among restorative dentists is that all endodontically treated teeth are weaker or more brittle than vital teeth and, therefore, require aggressive reinforcement. This aggressive treatment has traditionally consisted of insertion of a metal post or dowel to strengthen the tooth followed by placement of a crown to protect it.\(^13\) Reports as early as 1977 have raised serious doubt as to the strengthening ability of cemented posts and have recommended against the routine use of crowns for endodontically treated teeth.\(^11,14-17\) There is no doubt, however, that restored endodontically treated teeth have significantly greater longevity than do unrestored teeth or that some endodontically treated teeth can be restored with more conservative modalities than the traditional post and core covered with a complete crown.\(^11,12\)

Selecting the optimum restorative modality to compensate for the loss of coronal tooth structure is considered the key to restorative success. This selection process is often complicated by the many clinical techniques and post-and-core systems currently available.\(^18\) In the 10-year span from 1986 to 1996, there have been several articles discussing restorative techniques for endodontically treated teeth. However, not one provides the restorative dentist with a universal, uncomplicated, and systematic approach to selecting a restorative modality. The following restorative decision flowchart for endodontically treated teeth presents such an approach, based on logic and sound restorative principles (Fig 1). It is reliable, able to be verified numerous times; understandable; and universal in its application.

### Restorative decision flowchart

#### Assessment of restorability

The decision flowchart covers prosthodontic restorative guidelines for endodontically treated teeth. An endodontically treated tooth must be evaluated before definitive restorative procedures are initiated.\(^11,14\) Evaluation factors based on those stated by Rosenstiel et al\(^11\) are used to determine whether the endodontically treated tooth is restorable, unrestorable, or restorable following successful re-treatment. Definitive restorative treatment should not be initiated if the treated tooth exhibits:

1. Poor root filling
2. Active inflammation
3. Pressure sensitivity
4. Exudate
5. Fistula (or parulis)
6. Periodontal disease (moderate or severe periodontitis)
7. Severe loss of sound tooth structure (tooth would not benefit from crown lengthening or orthodontic extrusion)

In short, seven categories of infection, trauma, inflammation, unacceptable endodontics, or lack of restorability, as listed, can delay or cancel definitive restorative treatment. The choices of action, depending on the case, include:

1. Re-treatment
   a. Endodontic re-treatment (can reverse inflammation, permitting the tooth to receive restorative treatment)
   b. Periodontal re-treatment (tooth will require stabilization)
2. Monitoring (time to assess progressive healing)
3. Extraction (unrestorable)

If none of the aforementioned problems exists, then definitive restorative treatment may be initiated. The treatment guidelines for anterior and posterior teeth differ slightly because the teeth differ both morphologically and functionally.\(^11,12,14\)

### Restoration of anterior teeth

For an anterior tooth, complete coverage is not always necessary (Fig 2). However, in all cases where complete coverage is indicated, a post and core should be utilized.\(^11\) When coronal damage is minimal, and the tooth is esthetically acceptable, complete coverage is not required.\(^9\) Minimal damage is defined as a sound natural crown with a conservative access opening. In
Fig 1 Restorative decision flowchart.
Fig 2. Levels of coronal damage in anterior teeth. Central incisor with (a) minimal coronal damage, (b) moderate coronal damage, and (c) significant coronal damage.

Fig 2a

Fig 2b

Fig 2c

Fig 3. Levels of coronal damage in posterior teeth. Mandibular first molar with (a) minimum coronal damage, (b) moderate coronal damage, and (c) significant coronal damage.

Fig 3a

Fig 3b

Fig 3c
this situation, an acid-etched resin composite or reinforced glass-ionomer restoration will suffice. However, if the tooth is significantly damaged or serves as an FPD or RPD abutment, complete coverage is indicated and the tooth will require a post and core. Teeth that have undermined marginal ridges, loss of incisal edges, or coronal fracture are considered significantly damaged.

The shape of the pulp canal dictates the type of post and core system used. In a small circular canal, a prefabricated post and resin composite core may be used. If the canal is elliptical or flared, a customized post and core is deemed a necessity.

Restoration of posterior teeth

For all posterior endodontically treated teeth, cuspal coverage is indicated to conserve remaining coronal structure and to protect the weakened cusps from fractures. In the overwhelming majority of cases, there is sufficient coronal damage to require complete coverage. When coronal damage is minimal (intact buccal and lingual cusps) and the risk of fracture is low, an onlay restoration with no post may meet the cuspal coverage requirement. However, most posterior teeth are so damaged as to require a foundation and a complete crown. In cases where the damage is moderate (minimum of one sound cusp), or where there is extreme curvature of the roots, one of the following foundations may be used:

1. Amalgam coronal-radicular core
2. Pin-retained amalgam or resin composite

For an endodontically treated posterior tooth with little or no remaining coronal tooth structure, or one that is to be an FPD or RPD abutment, a post and core foundation is indicated. Again, the shape of the canals dictates the type or shape of post used. In those canals with circular cross sections, prefabricated posts and resin composite or amalgam cores are acceptable. In those canals that are extremely tapered, custom cast metal posts and cores are necessary.

Discussion

Figure 1 and the guidelines it sets forth are intended solely to serve as an aid, or template, for reaching restorative decisions, based on sound prosthodontic principles. The flowchart is in no sense intended to do anything other than to serve as a means of assisting the restorative dentist in making decisions concerning the restoration of endodontically treated teeth.

The authors expect that differences of opinion will continue to occur because dentistry is a dynamic, rather than monolithic, profession. There is almost no procedure that cannot be performed correctly utilizing more than one technique. It is also expected that cases will occur that do not fit the template perfectly. An example could be an endodontically treated anterior or posterior tooth with more tooth damage than the standard minimal but less than moderate destruction. The authors suggest that in cases of this nature, whether mild-moderate or moderate-significant, if any questions exist, the dentist should treat the tooth as requiring the more aggressive restoration protocol. Thus, mild-moderate is treated as moderate, and moderate-significant is treated as significant. Although most teeth will fit within the template, this method, in which the tooth is restored to the most serious level required, should assist the restorative dentist in coming to a treatment decision for almost every case.

Conclusion

Endodontic therapy is an essential component of the practice of restorative dentistry at the close of the 20th century. Dental practice and its success are inextricably tied to the quality of the final restoration. Before making a treatment decision, the restorative dentist must evaluate the quality of endodontic treatment, the periodontal support available, and the status of the remaining tooth structure. The subsequent restoration for the endodontically treated tooth is a function of the remaining tooth structure, the shape and configuration of the canals, and the functional and esthetic demands on the tooth.

Arriving at the best solution is a complex process, affected by many different variables, including available post systems and restorative foundation materials. Although there are additional experimental laboratory data on which to base a restorative decision, long-term controlled clinical data are not yet available. Restoring the endodontically treated tooth remains one of the most challenging problems facing the restorative dentist. An uncomplicated and systematic decision-making process, based on universally accepted philosophies and techniques, is necessary to maximize chances for a successful restorative outcome.
References


