Postendodontic Tooth Restoration - Part I: The Aim and the Plan of the Procedure

Sanja Šegović[1]
Nada Galić[1]
Ana Davanzo[2]
Božidar Pavelić[1]

[1]Department of Dental Pathology
School of Dental Medicine
University of Zagreb
[2]Health Centre "Centar", Zagreb

Acta Stomat Croat
2004; 81-86

Summary

Endodontic procedure requires removal of the pulp tissue and necrotic dentine, as well as a significant amount of healthy hard dental tissue, which results in reducing the resistance of the tooth to the occlusal loading forces. Restoration of such a tooth needs to satisfy requirements for retention of the restorative material, its resistance, as well as the resistance of the remaining dental tissue to occlusal forces, good coronal and intraradicular obturation and also aesthetic requirements.

Postendodontic treatment includes the following procedures: replacement of lost tissues using alloplastic materials directly or indirectly (amalgam, composite resin and glass-ionomer cement fillings or inlay, onlay or overlay restorations); the alloplastic material crown restorations using intracanal posts and parapulpal pins; the alloplastic material core buildup with or without intracanal posts and parapulpal pins covered with prosthetic crown; restoration of lost tooth structure using laboratory made post and core covered with prosthetic crown. Sealing of endodontic cavity using one of the alloplastic materials would be the treatment of choice in uncomplicated cases, whereas in severely damaged teeth ensuring remaining tooth structure by vertical stabilization and the prosthetic crown would be necessary. The choice of procedure depends on the severity of crown damage, the tooth position in the arch, occlusal contacts, morphology of root canal spaces, functional and aesthetic aspects, financial ability and available time for performing the procedure.

The correct indication evaluation respecting all steps of the chosen procedure will provide long term survival of the postendodontically treated tooth in the stomatognathic system.

Key words: *postendodontic treatment, post and core, alloplastic material, intracanal post, parapulpal pin.*

PROFESSIONAL PAPER
Received: February 28, 2003

Address of correspondence:

Sanja Šegović
Department of Dental Pathology
School of Dental Medicine
Gundulićeva 5, 10000 Zagreb
Croatia

Introduction

Endodontic treatment is an attempt at preserving a tooth with damaged pulp in function. The treatment success depends on numerous factors such as: variability of endodontic space morphology, available endodontic instruments, therapist's knowledge and clinical experience, patient's health and patience, time available for the treatment. Provided that the endodontic treatment was successful, confirmed radiographically and clinically, the task of the dental practitioner is to restore the tooth's function by supplying the crown and bringing it into correct relationship with adjacent teeth and antagonists. Postendodontic restoration today is considered equally important as the instrumentation and obturation of the root canal (1).

Prior to the postendodontic restoration, full clinical assessment of the endodontic procedure should be performed. Complicated restoration techniques are normally not carried out on teeth with questionable prognosis (2).

It is also important to consider the effect of restoration on the periodontal attachment, to maintain periodontal health. In cases of possible endangering the attachment of the tooth by reconstructing it, more complicated restoration methods are indicated, such as periodontal crown lengthening or orthodontic treatment (3).

Previous studies (4-12) evaluated different types of posts and cores regarding quality of retention and resistance, as well as sealing of canal space. All types of posts and cores are intended to provide a unique system of different materials and tooth structure which would ensure good sealing, retentive and resistance properties.

Effects of endodontic treatment on the tooth

The crown of the endodontically treated tooth could be distracted primarily because of carious process or trauma, and secondly because of preparing endodontic access cavity and restoration cavity.

The severely damaged crown is insufficient to perform its function due to the loss of contact points with antagonists and later with adjacent teeth. Also, attachment could be compromised, the adjacent teeth could lean, and antagonists could grow out. The consequences could be manifested throughout the stomatognatic system. Nergiz et al. (13) consider such a tooth weaker and more prone to trauma, and also anticipate changes in the chemical composition of hard dental tissues.

It is generally considered that such a tooth needs special attention while planning restoration, both temporary and final (14).

Structural changes and changes in dentine physical characteristics

There is widespread opinion that avital or endodontically treated teeth are more prone to fracture than vital teeth, although no definite evidence exists to confirm such statements.

Preparing access to the pulp chamber destroys structural integrity which is ensured by the dentine in the pulp chamber roof, allowing functional tooth deformation (2). However, this effect is considered to affect tooth strength less than the loss of the marginal ridge, in cases when the pulp chamber itself does not compromise the marginal ridge (15). Also, evidence exists that endodontic treatment reduces the tooth strength by 5%, while mesio-ocluso-distal preparation (MOD) of the II class reduces it by 60% (2).

The endodontic procedure certainly causes irreversible changes and weakening of the tooth. Probably not due to the treatment itself, but to the loss of a large proportion of hard dental tissues, initiated during pathological changes. Teeth are measurably weaker after preparation of the occlusal cavity. The loss of one of the marginal ridges additionally weakens the tooth by undermining the cusps, which become more prone to trauma, even when exposed to functional forces (2, 15). Undermined cusps deform under pressure until they are fractured and gaps occur between fillings and hard dental tissues. The restoration therefore must be planned to prevent such deformation of the cusps and consequent marginal leakage.

The trauma itself usually occurs at the smallest tooth radius, which is at the enamel-cement junction.

There are different opinions on whether endodontically treated teeth are more brittle due to the loss of moisture from the dentine caused by the loss of pulpal tissue. Papa et al. (16) reported that the moisture content of endodontically treated teeth was not reduced, even after ten years. Lewinstein & Grajower (17), Rivera & Yamauchi (18), Hauang et al. (19) and Sedgley & Messer (20) have determined by comparing the physical properties of treated and vital teeth, that no significant differences exist in hardness, firmness, collagen interconnections and amount of moisture between these teeth. Wagnild & Mueller (2), however, state that such changes do occur and result in 14% loss of hardness and resistance in endodontically treated molars, which in turn result in increased proneness to trauma. Helfer and Schilder (21) proved that endodontically treated dog teeth have 9% less moisture than vital teeth. Sedgley & Messer (20) suggested that it is rather the cumulative loss of tooth structure from caries, trauma and restorative and endodontic procedures that leads to susceptibility to fracture.

Some differences have been found between different teeth, i.e. maxillary teeth appear to be stronger than mandibular teeth, and mandibular incisors the weakest (2).

One should keep in mind that some types of postendodontic systems, particularly active retaining posts, could induce mechanical stress during cementation and functional loading causing root fracture and failure of the postendodontic restoration (22).

Aesthetic considerations

Biochemical changes in dentine modify the refraction of light through the tooth and change its appearance. Discoloration can also be caused by inadequate cleaning and shaping of the coronal space, which leaves fragments of vital tissues. Such tissue then disintegrates, and the products cause discoloration, which can also be caused or increased by intracanal medications and remains of the filling materials left in the chamber (23).

Postendodontic restoration

Long term success of endodontic treatment also depends on restoration of the endodontically treated tooth, which is supported by the fact that more problems and/or tooth losses in endodontically treated teeth are caused by inadequate restoration than by failure of the endodontic procedure itself. Also, while the unsuccessful endodontic procedure can be revised, an inadequately restored tooth is lost, either due to fracture in the weakened crown or root or during removal of existing intraradicular post because of canal retreatment. This was the motive for formulating postendodontic restoration guidelines, aimed at long term success of the treatment (15):

1. Enable full coronal sealing.
2. Enable resistance of the remaining tooth structure and retention of the filling.
3. Fulfil functional and aesthetic criteria.

Exposure of the filling material to oral fluids through gaps between the filling and the tooth or secondary caries will cause quick dissolution of the root canal filling. Compromised complete sealing of the root canal leads to the formation of spaces that can be contaminated by saliva and become good ground for the growth of bacteria (1, 24-26). In such a case, the establishment of direct communication with periapical tissue is only a matter of time (15), and even the best restorative construction cannot help. Even short term exposure of filling material to the oral fluid can create the need for revision. The speed of bacteria and saliva penetration vary in different patients and teeth, so the period of exposure that would necessitate revision remains unknown. (15). Torabinejad (27) found *in vitro* bacteria penetration throughout the entire length of a postendodontically unrestored root canal in 19-42 days. In general endodontic guidelines three months exposure time of unrestored obturated root canals to oral fluids has been suggested as maximum exposure time that mandates retreatment (15). In case of delayed definitive postendodontic restoration, adequate temporary restoration is required. Therefore, inadequate coronary sealing is one of the causes of periapical lesion. Retention and resistance of restoration and also resistance of remaining tooth structure are very significant for maintaining integrity of postendodontic system and function of treated tooth, as well as for preserving the filling of the root canal. Inadequate postendodontic treatment could lead to fractures and gap formations inside the restoration, tooth tissue or looting cement (28).

Planning restoration procedure

Planning of the restoration procedure begins even before endodontic treatment. After caries is removed and access cavity is prepared, the plan can be adjusted. Prior visualization of the reconstruction is important, so that practitioner can bear in mind basic principles of restoration during therapy.

Restoration plan depends on (29):

1. Position of the tooth in the arch.
2. Damage to the crown.
3. Functional requirements.
4. Tooth's role.
5. Root canal morphology.

According to the key directions for postendodontic treatment, three main procedures are defined for the basic plan (29):

1. Adding vertical stabilizers to the remaining tooth crown
2. Restoration of hard dental tissues using alloplastic materials
3. Final restoration procedure restoring the tooth's mechanical, physiological and aesthetic properties.

Vertical stabilization is performed by adding parapulpal and intracanal posts. Its purpose is to provide retention of the final restoration. It is important to assess correctly whether vertical stabilization is indicated, for inadequate use of the post can have serious adverse effects (30). Teeth with sufficient structure can be conservatively restored by filling or prosthetic crown using alloplastic core without pins and posts. (31).

Restoration by alloplastic material is performed for definitive restoration or for alloplastic core for crown. Different alloplastic materials are used: dental amalgam, composite, glass-ionomer cements, ceramic, precious legates...

Final restoration depends on the loss of hard dental tissues and the role of the tooth in question, and can vary from simple closing of the access cavity to full prosthetic crown, which replaces the entire structure (32).

Restoration plan for anterior teeth

Most teeth with healthy remaining tooth substance can be conservatively restored by filling of the access cavity. These teeth are not so prone to fractures and mostly do not require crown, core or post (2). The first choice material is usually composite resin. Glass-ionomer cement can be used for filling in case the surface is not subjected to forces from adjacent teeth (33). Trabert et al. (34) support the opinion that there are no significant differences in crown resistance in treated and intact anterior teeth.

In cases of more extensive damage to the tooth, the restoration procedure becomes more complicated. The restoration needs to satisfy both functional and aesthetic requirements, and full prosthetic crown is indicated. For example, to place an aesthetic crown, the preparation edges are placed in the gingival sulcus, and the most of enamel is removed from the labial side in order to place the veneer. When a more extensive prosthetic procedure involving posterior teeth is planned, occasionally even more dental tissue has to be removed to maintain parallelism. Sometimes, a post can be used to retain coronal restoration. It can be shortened, except in cases when the tooth is used to support a denture, in which case full post length is required. Anterior teeth have to resist lateral forces of the mandibule, which are transferred along the post and have a tendency to breake the tooth. The construction needs to put as little pressure as possible on the anterior teeth, and transfer the pressure on the adjacent and structurally stronger, intact teeth. Optimal restoration materials are a metal post and core or confection post with core made of alloplastic materials (amalgam, composite, glass ionomer) (15).

Restoration plan for posterior teeth

The access cavity can be easily restored in case there are no proximal fillings, caries, unsupported cusps and strong fassettes. In other cases, more complicated restorative procedures are performed. Posterior teeth always require coronal protection, as they are subject to greater occlusive pressure, regardless of the loss in hard dental tissues (15).

The number of surfaces included in coronal preparation depends on the status of proximal surfaces.

Whenever there is damage to the marginal ridge of avital tooth, buccal and lingual cusps have to be shortened (3 to 4 mm is recommended) and covered or connected, so that they form an 'unbroken chain' structure in the coronal part. Premolars are more vulnerable to fracture than molars and should have both cusps onlaid, while for molars, coverage of cusps adjacent to lost marginal ridge will generally be adequate, provided that the remaining cusps and marginal ridge are not undermined (15). The technique used in this procedure is usually MOD onlay or overlay (Figure 1).

In case the remaining cusps are undermined, the base of the tooth must be restored using an alloplastic material with parapulpal pins, and full reconstruction is performed by one of the extra coronal methods, such as onlay, overlay or prosthetic crown.

In case the cusps are missing, the root canal is used as a space for intraradicular retention.

Chamber volume and shape in posterior teeth can provide sufficient retention of the filling, so coronal-radical restoration without post can be used as a base for a full crown (2). Generally, all endodontically treated posterior teeth should be restored using a crown. It has been shown that a large number of posterior teeth fractures are prevented in this manner (35, 36).

Teeth with reduced periodontal attachment need full periodontal, endodontic and restorative therapy (37). Loss of attachment compromises restorative possibility and such teeth become more prone to fractures, as the clinical crown to root ratio changes in favor of the crown. Preparing such teeth for restoration, and especially when the furcation are affected, results in the loss of a large proportion of hard dental tissue coronary from the furcation due to the fact that the remaining tooth has to be shaped conically. In case the margin of preparation is located in the beginning of the gingival crevice, all convexities on the walls have to be removed. The margin of prosthetic restoration begins on the root surface, which has a smaller circumference than the enamel-cement junction. A post is needed to retain the prosthetic. However, the post is seldom as long as the clinical crown and often does not reach to the alveolar crest. The apical margin of the dowel should not end at the level of the alveolar crest but should terminate above or below the alveolus. The bony crest and dowel terminus are both stress concentrators, and coincident placement increases fracture potential (2).

Periodontal therapy of multi-rooted teeth may include amputations and hemisections. This procedure dramatically changes restorative therapy. Morphology of the remaining root structure, regarding the ephithelial attachment dictates the preparation of the remaining tooth structure, which, after endodontic treatment, mostly has the role of bridge supporter.

Severely damaged teeth

Such teeth require fulfillment of all criteria: from vertical stabilization to final restorative procedure. Final configuration, therefore includes the following parts (Figure 2):

1. Apical sealing ensured with 3-5mm of gutta-percha (A).
2. Remaining tooth structure and periodontal attachment (B).
3. Intracanal post, core, luting cement (C).
4. Definitive coronal restoration (D).

Often there is a collision between the mechanical requirements of the restoration and biological requirements of the periodontal attachment. The narrow zone of hard tissue remaining in the cervical third of the tooth is needed both for securing the retention of the restoration and for periodontal health. (Figure 3)

However, restoration is not always possible, such as in cases of (38):

1. Inconvenient anatomical and morphological conditions (curved roots).
2. Poor endodontic treatment, incorrectly filled canals.
3. Inconvenient jaw alignment..

Conclusion

Following the endodontic procedure, it is necessary to restore the original morphology and function of the tooth, which is accomplished by crown restoration. Less extensive damage to the crown is restored

by alloplastic materials, securing its retention. In the case of more extensive loss of tissue, restoration is only possible with additional retentive elements such as parapulpal or intracanal posts. The purpose of such retention is to anchor the filling and prevent fracture.

Restoration should begin at the earliest possible moment. The tooth exposed to oral conditions without adequate restoration cannot resist occlusal forces and oral fluid bacteria for an extended period. Incidence of fracture or periapical process in such teeth is only a matter of time. In case the adequate final restoration has to be delayed, a temporary filling needs to prevent complications.

Postendodontic restoration is as important as the endodontic treatment itself, as successful treatment cannot be achieved without correct postendodontic restoration.