Reconstruction of Endodontically Treated Posterior Teeth—with or without Post? Guidelines for the Dental Practitioner

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Abstract

The clinical concepts regarding the restoration of root canal treated teeth are not clear today and often based on conjecture due to a lack of sound empirical data. The diversity of published opinions is confusing and may lead to less-than-optimal treatment selections. There is also emerging debate whether or not a post is necessary. The purpose of the present article is to organize this topic in evidence-based principles and provide dental practitioners with clear guidelines about restorative therapy for premolar and molar teeth. Two clinical reports are presented, to exemplify the different clinical situations.

The first case highlights a conservative restoration of an endodontically treated molar, maintaining an adequate quantity of healthy residual tissue and only covering the cusp with restoration material, which was not sustained by healthy dentin. In the second case, the fact that the premolar was so badly damaged by carious pathology meant that it was necessary to use a pin to anchor the composite material, and the cusp was covered completely.

Based on the two presented clinical reports and a literature review, the concept of fiber post application is explained. Searches by hand and MEDLINE were employed to identify peer-reviewed articles on reconstruction of endodontically treated posterior teeth. A total of 70 articles published between 1967 and 2008 were reviewed.

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Introduction

Restoration of endodontically treated teeth represents a challenge for the practitioner, because it requires profound knowledge not only of restorative dentistry, but of endodontics and periodontics as well. The main reason for loss of endodontically treated teeth is their bad reconstruction. Unfortunately, the clinical concepts regarding the restoration of root canal treated teeth are not clear and often based on conjecture due to a lack of sound empirical data. The diversity of published opinions is confusing and may lead to less-than-optimal treatment selections. There is also an emerging debate about whether or not a post is necessary. The purpose of the present article is to organize this topic in evidence-based principles and provide dental practitioners with clear guidelines about restorative therapy for premolar and molar teeth.

Current status of endodontically treated teeth

Root canal treated teeth are supposed to be structurally different from unrestored vital teeth. It has been suggested that endodontically treated teeth dry over time and dentin undergoes changes in collagen cross-linking. Therefore it has been suggested that endodontically treated teeth are more brittle and may fracture more easily than vital teeth.

Fennis et al studied more than 46,000 patients from insurance claims and reported significantly more fractures in teeth with endodontic treatment. Moreover, after root canal treatment, the teeth usually presented inadequate remaining coronal structure. It is believed that it is the loss of the tooth structure from caries, trauma, or both that makes endodontically treated teeth more susceptible to fracture. Randow and Glantz reported that teeth have a protective feedback mechanism that is lost when the pulp is removed, which may also contribute to tooth fracture.

When a large portion of the clinical crown has been lost to damage, it is often impossible to achieve sufficient anchorage of a restoration in the remaining dentin. In such situations, a root canal-retained restoration is proposed to be required. For many years the cast gold post and core has been regarded as the “gold standard” in post-and-core restorations due to its superior success rate. Alternatives to cast posts and cores have been developed. The use of prefabricated posts and custom-made buildups with composite simplifies the restorative procedure because all steps can be completed chairside, and fair clinical success can be expected.

Prefabricated posts were initially made of gold-plated brass stainless steel, but were improved later by using titanium alloys as the basic material. The utilization of metallic posts yields a root fracture index of approximately 2 to 4%, which has been assigned to stress concentration. If two materials of different mechanical properties are united, stress is concentrated in the weaker material. This is apparent with metal and zirconia posts, which are mechanically stronger than natural tooth structure.

For that reason, fiber posts were developed that presented an elasticity modulus (E) closer to that of dentin (fiber post = 20 GPa, dentin = 18 GPa) when compared to cast posts and prefabricated metallic (E = 200 GPa) and ceramic posts (E = 150 GPa). This consequently allows for the absorption and uniform distribution of stresses to the
remaining root structure instead of concentrating them.27,28,30,31-33

The carbon fiber post was designed initially,34 followed by quartz fiber posts and glass fiber posts. The quartz and glass fiber posts were developed to compensate for certain esthetic limitations of the carbon fiber posts, since all of these posts present similar characteristics from a mechanical standpoint. Currently, prefabricated fiber-reinforced composite (FRC) posts are being used increasingly in dental clinical practice. Recently however, several papers supported the use of a direct restoration without placing any posts for restoring endodontically treated teeth.36-37

A recent study by Krejci et al38 discussed the need for a re-evaluation of post use, especially where adhesive techniques are used to construct the core. Fokkinga et al39 found no differences in mean failure load and failure mode between root canal premolars restored with or without posts. Earlier, several comparative in vitro studies demonstrated that the use of posts did not increase the fracture resistance significantly.36,40-42 Posts are used to retain the core material, so the indication for post insertion depends on missing hard tissues and the extent of either destruction or viable structure in the tooth being considered for endodontic treatment.

Ferrule effect

Additionally, the ferrule effect has a great influence on fracture resistance, especially in de-coronated teeth. The ferrule is a band that encircles the external dimension of the residual tooth, similar to the metal bands around barrel.43 A properly executed ferrule reduces the incidence of fracture in nonvital teeth by reinforcing the tooth at its external surface and dissipating force that concentrates at the narrowest circumference of the tooth.44,45 Crown preparation with as little as 1 mm coronal extension of dentin above the margin has double the fracture resistance of preparations in which the core terminates on a flat surface immediately above the margin.46,47 If deep destruction of the teeth renders a sufficient ferrule impossible, a periodontal crown lengthening or orthodontic extrusion can be performed.

Various in vitro studies have shown that fracture resistance can be significantly increased by the use of a ferrule; the post length or design are of secondary importance for fracture resistance if a sufficient ferrule can be provided.46,48,49 Bolhuis et al50 postulated that the crown ferrule is a more important issue than the choice between a post and core, or a core reconstruction with adhesive fillings only. The researchers50 examined de-coronated, root-treated premolars. These were rebuilt by a core buildup without an endodontic post or by a core buildup with an endodontic post (a cast post and core, and a composite with a silica post), an additional group was not provided with a core at all. No significant difference in fracture strength among the different groups could be demonstrated. However, the above-mentioned study was a pilot study; it was not controlled and randomized.

Restoration of endodontically treated molars vs premolars

For the dental practitioner it is important to take advantage of the anatomy of the molar teeth. Unless the destruction of coronal
Current consensus in restorative dentistry is that de-cementation or failure of posts is preferable to fracture of residual tooth structure. 27, 59 Whatever foundation will be carried out, post or composite core buildup only, it is important to perform it immediately after endodontic treatment whenever possible. 60 In vitro studies have shown that exposure of coronal gutta-percha to bacterial contamination can lead to migration of bacteria to the apex in a matter of days. 61, 62

**Core buildup**

Currently, composite is the most popular buildup and has some characteristics of an ideal buildup material. 52 It can be easily bonded to many of the current posts and to the remaining tooth structure to increase retention. 63 It has high tensile strength, low solubility, and the tooth can be prepared for an indirect restoration immediately after polymerization. Some of the negative features of resin-based composite are polymerization shrinkage, hydroscopic expansion as a result of water adsorption, and incorporation of voids during buildup, especially when self-cured composites are applied. 53

The C factor, defined as the ratio of the bonded to un-bonded surface area of cavities, is highly unfavorable in root canals where it can range from 20 to 200. 54 Adhesion to dentin on the pulp floor is generally not as strong or reliable as to coronal dentin. 65 Furthermore, resin-based composite is incompatible with zinc oxide eugenol in many root canal sealers, the combination of which can result in incomplete polymerization.
In the case of molars where posts are not used it is important to increase the surface of dentin by removing the gutta-percha remnants from the orifice of the root canals. It has been shown that contamination of dentin with temporary cements, saliva, and blood may lead to reduced bond strengths. Therefore, a rubber dam is an absolute requirement during the restorative procedure and perfect cleaning of the dentinal surface should be performed.

When light-curing composite is applied as a core buildup material, special care must be taken to ensure the proper time for polymerization and adequate lamp intensity are applied. Concerning the final restoration, there is convincing evidence that cuspal coverage should be provided for endodontically treated posterior teeth. Sorensen et al concluded from the retrospective evaluation of 1,273 endodontically treated teeth that the presence of cuspal coverage was the only significant restorative variable to predict long-term success.

Clinical applications

Case 1

A 36-year-old patient came to the surgery complaining of pressure pain on tooth 16. The tooth had been provisionally restored while on holiday after the partial loss of a restoration in silver amalgam (Fig 1).

The radiograph (Fig 2) showed a periapical transparency and it was decided that an endodontic intervention was needed on the tooth in question. It was decided that the inappropriate amalgam restoration on tooth 15 would be eliminated as well and two restorations would be applied in composite. For the teeth in question, the final treatment decision fell on an indirect composite restoration, a partial onlay, and an inlay.

When rebuilding one or more cusps with the need to optimize the form, the contact points, and occlusion, and if there is more than one restoration in the same hemi-arch, indirect restoration is chosen. This means two short appointments, rather than one long one, but it does give excellent results.

Figs 1 and 2 Initial clinical image and radiograph: the pulpal necrosis, confirmed by the vitality test, can be clearly seen.
Currently, composite offers diverse advantages. The ability to modify and correct, simple and rapid lab work, as well as better conversion than when the composite is cured during chair time. Once the restorations are removed, the secondary caries are accurately cleaned in order to be able to carefully evaluate the quantity and quality of the sound residual tissue (Fig 3).

Tooth 16 had a completely integral distal and vestibular wall of adequate thickness, while the palatine wall appeared intact on its distal cusp, but rather thin (>1.5 mm) in its mesial component. It was possible to treat this tooth as a vital element, proceeding parallel to the restoration on tooth 15 without using a post.

Next, adhesive phase (Clearfil™ Protect Bond, Kuraray, Okayama, Japan) was applied and a buildup in composite materials was constructed in order to optimize the dimensions of the inlay, which was subsequently prepared to seal the tubules of vital tooth 15. The material (Enamel plus HFO, Micerium, Avegno, Italy) was then applied in thin layers so as to reduce the danger of the restoration contracting on the healthy residual walls (Fig 4).

Once the restoration had been built up with layers of composite, a little glycerine could be applied and polymerized again for 1 minute so that there was a good film surface to work on with the preparation burs (Fig 5).

Then, the buildup was optimized by leaving at least 2 mm of space for the inlay by reducing the mesial-palatine cusp, which was to be completely reconstructed in composite. After applying 000 retraction cord (Ultrapak®, Ultradent, South Jordan, UT, USA), an impression was then taken (Fig 6) with precision material (Impregum™ and Permadyne™, 3M ESPE, St Paul, MN, USA).

The impression was sent to the laboratory where, in only a few days, the two inlays could be manufactured using the same material which had been applied as a base for the restoration (Fig 7).

The third appointment involved the cementing of the inlays and this is ideally done with the same light-curing composite which was used both for the buildup and for the inlays. It was then possible to remove the excess material and activate the light curing at the earliest convenience.

It is crucial, if this form of luting is used, to optimize the forms and dimension of the buildup and ask the technicians to use an abundant layer of wax on the bottom and wall of the plaster model (not on the margins!) before beginning the stratification of the inlay. This gap will be filled by the light-curing composite, which will have been heated in order to render it more fluid. Pre-formed matrixes were used (Sectional Matrix System, KerrHawe, Bioggio, Switzerland) during all of the adhesive and cementing stages (Fig 8). In this way, the neighbouring teeth are protected from any excess material which would be difficult to remove when cementing the contiguous element. It is recommended to never cement the two teeth at the same time (Fig 9).

The inlay was locked in by exposing it for a few seconds to the LED lamp before checking to see if there was any excess bonding or composite material. Once it has been ensured that all excess material has been removed, the curing lamp can be activated for 6 minutes, making sure to apply the lamp on all surfaces possible.

It is at this point that the finishing and polishing stages can be completed with rubbers, diamond paste, and shining materi-
Fig 3 Once the tooth has been treated post-endodontically and after the cavity has been thoroughly cleaned, the healthy residual tissue can be assessed and decisions made on the most appropriate restoration technique.

Fig 4 The composite restoration is built up very gradually in order to reduce curing shrinkage that causes stress to the walls.

Fig 5 Once the buildup has been completed, the final layer is cured with glycerine for protection.

Fig 6 The preparation is now complete and the retractor threads are positioned for a precision impression.

Fig 7 The composite inlays are ready for adhesive cementing.

Fig 8 A pre-formed transparent matrix (KerrHawe) is positioned in order to protect the adjoining cavity during the cementing phase of one of the inlays.
al (Shiny System, Micerium). The results achieved 6 months on can be seen in the check-up photograph (Fig 10). In the bite-wing radiograph, the different radiopacities of the composites used can be appreciated (Fig 11).

Case 2

A twenty-year-old girl came to us with intense spontaneous pain in the fourth quadrant (Fig 12). The bite-wing radiograph showed the presence of deep caries on both of the healthy teeth and those that had already been restored. Tooth 45 was especially damaged and this was the probable cause of the girl’s pain; however, teeth 44, 46, and 47 also required restoration work.

The depth of the cervical lesion on tooth 45 was notable (Fig 13). It was decided to carry out a radical therapy of removing the caries and restoring the teeth in a single appointment. This would allow for a complete view of the operative field and the ability to make the appropriate decisions. In fact, this type of treatment saves chair time and means that the patient’s pain can be eliminated. The reason for this is that
The initial case: the pain that the patient was complaining of may have been caused by more than one element on the same hemi-arch.

A caries detecting solution can aid in the selective elimination of pathological tissue.

Concerning the cervical depth of the lesion on tooth 45, it was impossible to think of any restoration without creating an adequate biological width. The rubber dam was taken off and straight away the periodontal surgery was carried out to support the restoration phase (Fig 16).

It may be apparent why the surgical work was carried out at this stage, which has many advantages. For one, the working field, without the interference of the old restorations, is ideal and allows for more precision when removing bone and gum tissue. This makes it possible to suture pre-
Fig 16  Once the rubber dam has been removed, the clinical crown of 45 can then be lengthened in order to establish a correct biological amplitude.

Fig 17  The rubber dam was immediately positioned and the endodontic treatment of 45 and the preliminary restoration of the teeth in the arch were begun.

Fig 18  Restoration using a post on tooth 45: trying the post.

Fig 19  Restoration using a post on tooth 45: positioning with dual cement.

Fig 20  Restoration using a post on tooth 45: reconstruction with a light-curing restoration.

Fig 21  Detail of the precision impression which was carried out with a polyether (Impregum and Perma-dyne, 3M ESPE).
Figs 22 and 23  A radiograph taken after the buildup to evaluate the biological space obtained and the thickness of the inlay preparations, and a clinical image of the finished preparations.

Figs 24 and 25  Work models and inlays ready for luting.

cisely, immediately put on the rubber dam, and carry out the endodontic and buildup work on the teeth in question (Fig 17).

Considering the reduced thickness of the residual coronal tissue on tooth 45, a fibre post was needed to support the buildup. The post was first tried for size after the canal had been adequately prepared. The correct length was marked with a pen (Fig 18) and the post was then extracted and cut to length outside of the mouth. It was then positioned with a dual cement (Figs 19 and 20).

With the inter-dental papilla out of the way, this was the ideal moment to take a precision impression for manufacturing composite inlays (Fig 21). A composite crown was made for tooth 45 for the following reasons: the age of the patient, the presence of enamel on almost the entire circumference, and because the tooth was the antagonist, which was also reconstructed using composite (Fig 23).

During the appointment 5 days later to remove the sutures, the restorations were positioned as described in case 1 (Figs 26
In the case of endodontically treated molars, if adequate coronal dentin is present and the pulp chamber provides adequate retention for a core buildup, no additional fiber post reinforcement is needed. A fiber post should be used during reconstruction of endodontically treated molars in the case where there is an absence of coronal dentin. During core buildup reconstruction, especially when

Conclusions and guidelines for practitioners

As a result of the present review and the authors’ clinical experience, several conclusions and guidelines for practitioners can be drawn.

and 27). The final images illustrate the achieved results (Figs 28 and 29).

In the case of endodontically treated molars, if adequate coronal dentin is present and the pulp chamber provides adequate retention for a core buildup, no additional fiber post reinforcement is needed.

A fiber post should be used during reconstruction of endodontically treated molars in the case where there is an absence of coronal dentin. During core buildup reconstruction, especially when
no post is applied, special care has to be focused on achieving the best possible adhesion to the dentin through:

- rubber dam isolation
- removing gutta-percha remnants from the orifice of the root canals
- perfect cleaning of the dentinal surface
- adequate application of the bonding system
- adequate light-curing of the bonding system and resin composite
- incremental placement of the composite to reduce polymerization shrinkage and achieve satisfactory marginal adaptation.

During the restoration of endodontically treated premolars, use of a fiber post is recommended for the length at least equal to the length of the crown.

Fiber post placement or composite core buildup restoration should be performed immediately after endodontic treatment whenever possible.

References


