Direct anatomical posts for weakened roots: The state of knowledge

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Abstract
The direct anatomical posts (composite resin associated with prefabricated glass fiber posts) become a new treatment option for rehabilitation of weakened roots. From a literature review, this paper aims to prospect the indications, advantages, preparation technique illustrated by a step-by-step protocol and results of in vitro studies about this new proposal for restorative treatment of weakened roots, which is presenting itself as a suitable alternative to conventional cast metal post-and-cores. Clinical significance: In clinical practice, the dentist is faced daily with the need to restore teeth with weakened roots. In such cases, the technique of direct anatomical posts has been presented as a good alternative because it involves a technically simple procedure and allows to obtain biomechanical and esthetic favorable results.

Keywords
Composite resins, dental pins, post and core technique

Introduction
Despite the constant improvement of techniques and restorative materials, weakened roots restoration continues to be a challenge to clinicians.¹⁻⁴ The wide damage of the root may result from dental caries extension, over-preparation, trauma, immature development, internal resorption, or removal of a previous placed excessively large dowel and core.²⁶⁻⁷ The residual thin root wall makes the restoration more difficult which can implicate in a poor prognosis to the long-term functionality of the restored tooth.¹⁺⁸

For a long time, cast metal post-and-core was the treatment of choice for endodontically treated teeth without taking into account the quantity and quality of the remaining tooth structure.⁷ As they were obtained from an impression taken directly from the root canal, these conventional posts offer a good fit to the canal providing high retention and thin cement layer. However, according to several studies,⁹⁻¹⁰ they present high elastic modulus potentially leading to root fracture,¹⁻¹³ due to their great stiffness in homogeneity between metal and dentin.¹⁻¹³ Given these circumstances, the use of prefabricated glass fiber posts became popular in restorative dentistry, and they have been used as a more aesthetic and biologically favorable alternative to custom metallic posts.²⁻⁶⁻¹⁵

The similar elastic modulus observed between the glass fiber post, resin cement, and dentin may provide adequate stress distribution on the tooth decreasing the incidence of catastrophic root fractures.¹⁻¹³⁻¹⁶ This feature is thus considered beneficial to obtain a better performance of the dental element restored.¹⁻¹⁸

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the formation of bubbles, and consequently creating a potentially weak area in the restoration.

In order to prolong the stay of the tooth in function in the oral cavity and to avoid its extraction, some authors have been suggested to fill the void with restorative materials, such as composite resins,[1-4,20,22] glass ionomer cement,[22] and accessory glass fiber posts.[4,5] However, the relining of the fiber post with composite resin has been the most widely used solution, creating an individual anatomic post.

Considering the widely use of the direct anatomic posts, the aim of this paper is to conduct a succinct literature review concerning this restorative technique, in order to benefit the clinicians’ indication, preparation, and cementation of these types of posts, based on the results of original scientific papers. In order to illustrate the preparation technique, step-by-step clinical protocol will be showed.

**Literature Review and Discussion**

**When and why use direct anatomical posts?**

The use of intraradicular posts is a common way to restore endodontically treated teeth when their remaining coronal portion can no longer provide adequate support and retention for the restoration.[18,23] The rehabilitation of endodontically treated teeth is a very complex procedure, whereas in many cases these teeth are widely destroyed, raising questions about the type of intraradicular restorative material to be used.[6]

For a long time, custom-fabricated cast metal post and core were the only treatment option to restore the lost tooth structure due to endodontic treatment. However, these posts show some disadvantages such as: lack of retention of luting agent; possibility of corrosion; high stress transmission to the tooth structure, which can lead to root fracture; trouble to remove them, if necessary; longstanding working time; laboratory costs and high modulus of elasticity.[11,13] The high rigidity of the cast metal post and core can generate a wedge effect, what can lead to extensive root fractures, requiring the tooth extraction.[11]

In weakened roots or flared canals, the rate of root fracture increases substantially. This is due to the substantial loss of root structure, making a flared canal structurally weak when compared to a tooth with wide radicular dentin structure.[6] A root is considered weak when it has a remaining dentin thickness of 1 mm or less, most commonly in the proximal region,[20] and the morphology of flared canals results in wide, tapered, and non-retentive roots.[7]

The integrity of the radicular dentin volume is directly correlated to the maximum load capability of a root.[23] Dentin undergoes considerable plastic deformation during the normal masticatory function, and, for this reason, it is able to withstand varying degrees and angles of load. However, when load exceeds the tensile strength, the ability of dentin for plastic deformation decreases, leading to fracture.[14,23]

A new concept of restorative system emerged with the introduction of fiber-reinforced posts, where the several components of the restoration (adhesive system, luting agent, post and filling material) are a mechanically homogeneous structural complex. This monoblock complex shows physical properties similar to dentin, favoring the integrity of weakened roots.[12,26,27] According to Stewardson,[28] the use of posts with softer materials than dentin would generate less stress transfer to root structures, avoiding root fractures, and favoring post cementation. Regarding health concerns, non-metallic posts besides render esthetic superiority over the metallic ones they also avoid the possibility of corrosion, reducing the risk of toxicity.[29]

When using prefabricated posts in flared roots, it remains a great thickness of luting agent between the post and the root dentin, which may cause a decrease in resistance. Thus, it is preferable to use accessory fiber posts[12] or the direct anatomical post technique,[30] decreasing the cement thickness and increasing the strength of the complex.

Boudrias et al.[31] in 2001, described the use of anatomic post as a technique where the fiber post is relined into the root canal replacing the luting agent by composite resin. Among the advantages of this technique are the reduced resin cement layer and the better physical and mechanical properties of the composite resin when compared to resin cement. The importance of a thin cement layer is to reduce the presence of bubbles, and other defects within this layer, since voids may act as crack raisers, decreasing post retention.[19,21] According to Faria-e-Silva et al.[31] to reline the post may reduce the possibility of cohesive failures and increases the cement layer strength.

The use of anatomical posts is a current clinical trend. The technique has been reported as a simple and safe procedure and that can be made in only one session.[30] This type of post is recommended mainly to excessively iatrogenically-enlarged, conical or elliptical canals because it favors the juxtaposition of the post relative to the root canal walls, which increases the mechanical retention and reduces the volume of resin cement. This reduction contributes significantly to reduce the stress in the adhesive interface during polymerization shrinkage. In the complex tooth/post/core, the cementing agent is the weakest link, so a large amount of cement may compromise the long-term prognosis.[1-3,20]

Considering the restoration of flared roots, the use of composite as a filling material has been released.[1-4,20,22] However, most studies in the literature are associated with the use of light-transmitting plastic posts to promote root reinforcement through the polymerization of the resin directly into the root canal.[2,20]

Some studies have been suggested that endodontically treated teeth are more brittle and may fracture more easily than vital-pulp teeth.[32] It is believed that this weakness occurs due to the loss of tooth structure from several reasons[33] associated to teeth drying out over time[34] and to the fact that endodontically treated teeth undergoes changes in collagen cross-linking.[35] The question of whether posts strengthen or not pulpless teeth
has generated extensive discussions in the literature. However, the most accepted idea is that retention is the main function of a post in order to support a core and the final restoration.

**How to prepare the direct anatomical post?**

Figures 1-22 illustrate the clinical protocol of making a direct anatomical post using a model with acrylic teeth, aiming for a better view of the technique.

**Considerations about Cementation**

In a study by Ferrari et al.,[27] it was observed the adhesion between prefabricated fiber posts, bonding agents, resin cement, and composite resin. After 6 years of clinical and radiographic evaluation, the authors observed only 3.2% of failure rate using prefabricated quartz fiber and carbon posts cemented by adhesive technique. This possible chemical union with a strong adhesive integration of these components to the tooth reinforces the indication of using anatomical posts for roots with flared canals.

**Figure 1:** Representative model of a flared root canal, where it can be noticed the mismatch of the prefabricated post to the root canal

**Figure 2:** It can be noted that the space between the post and the root wall can be filled by two accessory posts. We decided to use the accessory posts associated to the post-relining technique with composite resin, seeking better fit of the post to the root canal, and reduced cementation line

**Figure 3:** Cleaning of the posts with 37% phosphoric acid

**Figure 4:** Applying a thin layer of adhesive to the posts

**Figure 5:** Isolation of the root canal with a glycerine-based gel with the aid of a microbrush
However, one important factor that should be considered during cementation of non-metal posts is the compatibility between the luting agent and the adhesive system. Failures in the union of conventional one-bottle adhesives and chemically activated resins have been observed.\textsuperscript{[36-38]} These failures result from the interaction between the acid monomers present in the adhesives, especially in the oxygen-inhibited surface layer. This phenomenon should be considered in the adhesive cementation of intraradicular non-metallic posts when employing chemically activated or dual cements, together with adhesives containing acidic

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image1.png}
\caption{Filling of the root canal with a micro-hybrid composite resin}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image2.png}
\caption{Insertion of the main fiberglass post}
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\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image3.png}
\caption{Insertion of the accessory posts}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image4.png}
\caption{Photo-activation for 10 s}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image5.png}
\caption{Removal of the anatomical post of the root canal and complementary extra-oral photo-activation for 40 s}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image6.png}
\caption{Surface treatment of the post performed with 37\% phosphoric acid for 60 s}
\end{figure}
monomers. One-bottle adhesives are incompatible with any material that has chemical polymerization reaction, but three-step adhesives offer no risk to chemical compatibility of the luting agent.

Scientific Evidence

Clavijo et al. investigated the fracture strength of simulated flared bovine roots after restoration using different post systems. They observed high fracture strength values for cast metal post-

Figure 12: Rinsing with spray air/water for 30 s followed by drying.

Figure 13: Application of a three-step adhesive.

Figure 14: Conditioning of the root canal with 37% phosphoric acid for 15 s followed by rinsing with air/water spray for 15 s.

Figure 15: Drying of the canal with absorbent paper cones to prevent excessive dehydration of the remaining root.

Figure 16: Applying of a thin coat of primer, followed by brief air-drying and application of adhesive.

Figure 17: Removal of the excess of adhesive with absorbent paper cones.
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and-core and indirect anatomic post. However, the group that used the technique of direct anatomical post, despite having lower values showed statistical similarity with the groups listed above, and only the occurrence of favorable failures, as well as the group in which the indirect anatomical post was used. The authors pointed out that the direct anatomic posts have a relatively easy fabrication technique, and that by adding only a few more steps to those required to cement a conventional fiber post, it is possible to achieve better fitting quality, thus minimizing the existence of voids and bubbles in the cement layer.

In a similar study, Silva et al.[7] tested the hypothesis that relining fiber posts with composite resin could increase the fracture resistance and decrease the root strain. It was observed that groups restored with composite resin relining or the groups restored with accessory glass fiber posts revealed more efficient results in high values of fracture resistance than a control group in which it was cemented glass fiber post in non-flared roots. The relined groups also demonstrated more repairable fractures. Considering the root strain, the obtained values were similar for all groups. So, the hypothesis was partially accepted.

The retention of relined posts was evaluated by Faria-e-Silva et al.[18] through a push-out bond strength test. It was compared a group of bovine flared roots restored using fiber posts without relining against another group restored with fiber posts relined with composite resin. Anatomically relined fiber posts presented higher retention values than non-relined post in all thirds of the roots. The authors considered the relining with composite resin
as an effective method to improve the retention of fiber posts to flared root canals.

Conclusions

Through this review, it became clear that the use of direct anatomical posts, when properly indicated for restoration of excessively large root canals, is rational technique, since it has advantages as technical simplicity, using materials with elasticity modulus close to dentin and also provides favorable esthetic results. However, further results from longitudinal clinical studies are needed to confirm the effectiveness of the technique in a long-term.

Clinical significance

In clinical practice, the dentist is faced daily with the need to restore teeth with weakened roots. In such cases, the technique of direct anatomical posts has been presented as a good alternative because it involves a technically simple procedure and allows to obtain biomechanical and esthetic favorable results.

References