Sealing Ability of Esthetic Post and Core Systems

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ABSTRACT

Aim: To review the literature on the sealing ability of esthetic post systems with different cementation techniques.

Background: An important factor for successful root canal treatment is the development of a coronal seal to the treated root canal system.

Review result: The current literature describes promising results using fiber posts with a dual-cure, self-etch resin cement system. However, none of the published results describe a post system or cementation technique that achieved a homogeneous and tight coronal seal.

Conclusion: Fiber post systems appear to be favorable alternatives to metallic or ceramic post systems. Furthermore, dual-cure, self-etch resin cement systems represent superior alternatives to other cement systems.

Clinical significance: The clinician should be aware of the differences between various post systems and different cement systems to select and apply the most appropriate post and cement in each clinical situation.

Keywords: Coronal seal, Fiber post, Microleakage, Resin luting cement.


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Conflict of interest: None

INTRODUCTION

The use of intracanal posts is a common clinical procedure to reinforce the remaining tooth structure and to provide a coronal seal to treated root canals. It has been reported in the literature that the survival of endodontically treated teeth relies significantly more on coronal sealing provided by coronal restoration than it does on apical sealing provided by root canal therapy.1

The most common post and core used in the literature is a custom-casted post and core. This type of post and core exhibits a high clinical success rate. However, the laboratory stage of the procedure, after an impression is taken for the tooth, requires more time and an additional visit to cement the post and core. To minimize the time required for the procedure, a prefabricated post and core has been introduced to the dental field.2,3

The metallic post and core have long been in use. According to the literature, there are some disadvantages associated with metal posts and cores, including loss of retention, corrosion, necessity of removing more root structure, concentrated stress, and the possibility of an unacceptable esthetic result.2,3

These complications have increased researchers’ interest in inventing new alternatives, which has led to the introduction of the zirconia, carbon, glass, polyethylene, and quartz fiber post systems. The fiber post systems exhibit particular advantages, including a modulus of elasticity similar to dentin and more conservative post-preparation. The primary disadvantage is debonding, which is considered a repairable complication.2,4-8

In 2005, Mannocci et al9 presented a study that proved that restorations with fiber posts and composites were more effective than amalgam in preventing root fractures but less effective in preventing secondary caries. For prevention of secondary caries, the extent of microleakage should be taken into consideration while placing adhesively luted fiber posts.

Microleakage of Cemented Fiber Posts

The coronal seal of the root canal treatment improves the treatment’s prognosis and is considered one of the primary factors of successful root canal treatment.3,10-12

The coronal seal prevents the leakage of bacterial endotoxins into the root canal area. The leakage of
bacterial endotoxins causes recurrent caries and cement disintegration, which may eventually lead to treatment failure. However, none of the currently used materials for cementing the fiber posts exhibit optimum sealing characteristics.2,3,13

The sealing ability of restorative materials and techniques is measured by microleakage evaluation. In the literature, many methods for evaluating the microleakage in both in vivo and in vitro studies have been reported. For in vitro studies, the methods include the use of dyes, chemical tracers, radioactive isotopes, air pressure, bacteria, neutron activation analysis, scanning electron microscopy, artificial caries techniques, and electrical conductivity.5-8,14-16

This report will present the recent literature results of microleakage studies in vitro for different esthetic posts with different cementation techniques. The difficulty in comparing the recent studies that evaluate microleakage is a result of the different evaluation methods used. Table 1 presents the studies and the evaluation methods used.

### Table 1: Microleakage evaluation methods

<table>
<thead>
<tr>
<th>Study</th>
<th>Method of microleakage evaluation</th>
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<tbody>
<tr>
<td>Usumez et al17</td>
<td>Fluid filtration method</td>
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<tr>
<td>Demir et al18</td>
<td>Fluid filtration method</td>
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<tr>
<td>Jung et al19</td>
<td>Dye penetration method</td>
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<tr>
<td>Sari and Özyesil20</td>
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<tr>
<td>Reid et al7</td>
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<td>Rogić-Barbić et al23</td>
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<td>Tjian et al24</td>
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<tr>
<td>Mannocci et al5</td>
<td>Dye penetration</td>
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**Prefabricated Glass and Quartz Fiber Posts**

Esthetic silica-based posts were introduced in 1992. These posts are made of silanized glass or quartz fibers bound by methacrylate or an epoxy-polymer matrix with a high degree of conversion and a highly cross-linked structure that binds the fibers.32 The fibers provide strength and stiffness, and the matrix transfers load to the fibers.33

Fiber posts contain bisphenol A glycidyl methacrylate and epoxy resin, which are suitable for the bonding technique. The bonding to dentin is achieved through chemical and micromechanical bonds that create a uniform stress distribution model.34 Because of bonding and the similarity of the elastic modulus to dentin, the biomechanical performance is superior to zirconia.35

Quartz is a crystalline form of silica, whereas glass is monocrystalline, and both are silica-based fibers. The quartz fiber posts are more radiopaque and exhibit higher flexural strength than fiber posts, and teeth restored with quartz fiber posts exhibit higher fracture strength.36-38

The literature reports the favorable sealing ability of fiber post systems. In 2004, Usumez et al17 reported less microleakage with glass fiber posts relative to systems using prefabricated stainless steel or zirconia posts. A similar result was published by Demir et al18 in 2014. The authors reported less microleakage with glass fiber posts than with the stainless steel post system. Furthermore, Jung et al19 found that the cast-post group exhibited a significantly higher level of microleakage relative to the glass fiber post group.

However, Sari and Özyesil20 reported that the sealing ability of the glass and quartz fiber post systems was not superior to that of stainless steel posts, and there were significant differences among the sealing abilities of various fiber post systems.

**Polyethylene Fiber Post**

The polyethylene fiber post was introduced in 1992 and is composed of plasma-treated ultra-high molecular weight polyethylene fibers woven into a three-dimensional structure. The fibers are pretreated using cold gas plasma, which improves bonding to resin materials.39 The advantages of this post type are a high elasticity coefficient; high resistance to stretch, distortion, and traction; and prevention of crack propagation.40,41 Furthermore, the fibers adapt to the root canal, minimizing the need for canal enlargement and decreasing the perforation potential. However, the high cost of polyethylene fibers limits their use in daily practice.

The idea that improving the adaptation of polyethylene fiber post systems will reduce microleakage has been proven by several different studies. In 2004, Usumez et al17 reported a smaller degree of microleakage with
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resin-supported polyethylene fiber and glass fiber dowels relative to systems using a prefabricated stainless steel or zirconia post. In 2008, Erkut et al. reported similar results. In 2014, Demir et al. reported less microleakage with resin-supported polyethylene fiber than with the stainless steel dowel system. However, in 2012, Başaran et al. detected no significant differences in microleakage among the glass fiber, quartz-glass fiber, zirconia-glass fiber, or polyethylene fiber systems.

Zirconia Post

All-ceramic restorations have become more popular due to their excellent esthetic properties. Therefore, the use of esthetic posts is recommended for restoring root canal-treated teeth that are located in the esthetic zone. Partially stabilized zirconium dioxide was introduced in 1980. Zirconium dioxide is a ceramic material formed by adding yttrium oxide with high fracture and bending strength.

Zirconia posts exhibit advantages that include their biocompatible nature, chemical stability, favorable physical properties, excellent opacity, and light transmission properties. Furthermore, the Young’s modulus is similar to that of the stainless steel alloy. The drawback of the zirconia post is that the high elastic modulus causes stress that can lead to root fracture.

The sealing ability of zirconia post systems compared with that of other systems has been evaluated by different studies. Mitov et al. reported that zirconia provides the same level of coronal sealing to that of fiber post and titanium post systems. However, the retention value was inferior to that of fiber posts. Jung et al. ranked the microleakage value of the four-post system. The authors reported that the sealing of the zirconia post system was superior to that of casted metal post, prefabricated metal post, and fiber post systems. A similar result was reported by Demir et al. in 2014, who observed a lesser degree of microleakage with the zirconia post than with the stainless steel post system. Similarly, Reid et al. concluded that titanium posts exhibit greater microleakage than fiber posts and zirconia posts. However, Usumez et al. reported that the fiber post system exhibits less microleakage than stainless steel and zirconia posts. Together, these studies suggest that zirconia posts provide acceptable sealing at the level of the coronal structure. However, the mechanical properties do not make zirconia posts a good esthetic choice of post.

Sealing Ability of different Cementation Techniques

Literature reports suggest that resin cements are the cement of choice to cement fiber posts because they improve the retention of the post compared with that of conventional cement. Resin cement systems can be divided based on curing methods (light-cured, dual-cured, and chemically cured) and according to the adhesive systems used (total-etch, self-etch, and self-adhesive). The most popular bonding agents have two components: Hydrophilic and hydrophobic. This feature makes the agent bond to intra-radicular dentin and the fiber post with micromechanical and chemical bonds. These bonds minimize microleakage and reduce the incidence of recurrent caries.

To cement the fiber post resin, cement systems can be divided into conventional resin cement and self-adhesive resin cement.

Conventional Resin Cements

Conventional cements provide a bond using either total-etch or self-etch adhesives. Total-etch resin cements use a 30 to 40% phosphoric acid-etch to etch dentin and enamel. There are many cements that fall into this category, including ARC (3M ESPE), Nexus (Sybron-Kerr), Variolink II (Ivoclar Vivadent, Inc.), Choice 2 (BISCO, Inc.), and Calibra (DENTSPLY Caulk). This multistep application technique is complex and, consequently, might compromise bonding effectiveness because each step represents a possible contamination point. The self-etch adhesive minimizes the steps and produces a similar result.

There are many types of cement that fall into the self-etch category, including Panavia 21, Panavia F, Panavia F 2.0 (Kuraray Medical, Inc.), and Multilink (Ivoclar Vivadent). Because the adhesion proposed is in an intracanal area where the accessibility of light curing is questionable, the recommendation is to use a self-curing or dual-curing adhesive. Comparison of the self-curing and dual-curing adhesives to light-curing adhesives showed that dual- and self-curing adhesives create an acceptable bond and produce a similar shrinkage value.

Self-adhesive Cements

Self-adhesive cements were introduced to the dental field in 2002. These cements address the problems associated with the use of conventional and resin cements. The main advantage is their single-step application, with no need to prepare the surface before cementation. This process minimizes the time required and eliminates the technical problems associated with multiple steps. There are many cements that fall into this category, including RelyXUnicem (3M ESPE), BisCem® (BISCO, Inc.), Maxcem Elite™ (Kerr Corporation), and SpeedCEM™ (Ivoclar Vivadent, Inc.).

The efficiency by which the resin cements adapt to and seal margins is critical to their success. When
the microleakage of resin cements is analyzed, studies have reported conflicting results due to the different methods of evaluation. However, resin cement exhibits less microleakage than resin-modified glass ionomer and zinc phosphate cements. In 2013, Rogić-Barbić et al.23 compared the sealing ability of Variolink II cement (dual-curing luting composite system), Harvard cement (Zinc phosphate cement), and Fuji PLUS cement (resin-reinforced, glass ionomer luting cement). Resin cement exhibited significantly less fluid movement. Similar results were reported by Tjan et al.,24 who used second generation dental adhesives, such as Gluma (Heraeus Kulzer), Tenure (Kuraray), and Scotchbond 2 (3M ESPE), and observed that posts luted with dentin-bonding cements, such as glass ionomer or zinc phosphate.6,24 Rogić-Barbić et al.23 evaluated the microleakage of different adhesive systems applied to reconstruction systems based on glass fiber posts. Fuji brand cement (glass ionomer) and Variolink II cement (resin-based cement) had the lowest microleakage values.

The self-etch resin cement exhibits greater sealing ability than self-adhesive resin cement. This result was reported by Erbaşar et al. in 2015. The authors compared Panavia F with Smartcem 2. Panavia F, which is a self-etch resin luting cement exhibited less microleakage than the Smartcem 2, which is a self-adhesive resin cement. The authors also found that the sealing ability of self-etch resin cement was superior to the zirconia temporary filling materials containing zinc oxide eugenol had no detrimental effect on the marginal seal.

CONCLUSION

Within the limitations of the presented studies and the different methods of evaluation, the following conclusions were drawn:

- None of the investigated post systems or cementation techniques achieved a homogeneous and tight seal at the post–cement–dentin interface; microleakage was reported for all materials.
- Fiber post systems appear to be favorable alternatives to metallic or ceramic post systems. Furthermore, dual-cure, self-etch resin cement systems represent a superior alternative to other cement systems.
- The clinician should be aware of the differences between post systems and cement systems to select and use the most appropriate post and cement for each clinical situation.

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