The effects of root canal perforation repair materials on the bond strength of fiber posts

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Abstract

Introduction: This study aimed to evaluate the effect of calcium hydroxide and bioceramics used in perforation repair on the bonding strength of fiber posts via a push-out test.

Methodology: This study used 106 extracted single-rooted human mandibular premolar teeth. Root canal preparations were performed with a rotary file system and perforations were created in the middle third of each tooth. The samples were randomized into two main experimental groups, one with calcium hydroxide and one without. Each group had four subgroups in which different bioceramic cements were applied (n = 11) and a control group (n = 9). The root canals perforations were repaired using MTA, Biodentine, Bioaggregate, and Endosequence BC root repair material. A fiber post was applied to each tooth and a push-out test was performed. The samples were examined at 40× magnification with a digital microscope in order to identify fracture type.

Results: Bonding strength was calculated in MPa. A statistical analysis showed that the calcium hydroxide had no effect on the bonding strength of the fiber posts. A comparison of the perforation repair materials revealed that Biodentine in the calcium hydroxide group and Bioaggregate in both groups decreased the bonding strength compared to the other materials (p < 0.05). The most common failure type was adhesive failure between the dentin and resin cement (38.16%).

Conclusions: The use of different perforation repair materials can affect the bonding strength of fiber posts. Therefore, the choice of perforation repair material should be made on an individual basis.

Keywords
MTA, biodentine, bioaggregate, endosequence, fiber post

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Introduction

Failure of root canal treatment is usually due to procedural errors that lead to uncontrollable endodontic infection and results that fall below acceptable standards.¹ Perforations have been shown to be the second-leading cause of endodontic failure, with iatrogenic root perforations detected in between 2% and 12% of endodontically treated teeth.² Perforations may be observed during access-cavity preparation, root canal shaping or filling, or post insertion.³ In order for a root perforation to be treated successfully, it must be sealed with a material that can prevent or eliminate bacterial infection at the perforation site.⁴ For these reasons, calcium hydroxide (Ca(OH)₂) and bioceramic materials have come into widespread use for perforation repair.

The antibacterial properties of Ca(OH)₂ and its ability to inhibit root resorption and promote calcification have led to its frequent use as an intracanal medicament.⁵,⁶ Calcium hydroxide’s therapeutic effectiveness stems from its release of hydroxyl ions, which increases the pH⁷ and thus the effectiveness of alkaline phosphatase, an important enzyme in alkaline-pH calcification, which requires an optimal pH.
of 10.2.10 The hydroxyl ions in Ca(OH)₂ also denature bacterial proteins and destroy bacterial DNA.9 According to a study by Nerwich et al.,10 hydroxyl ions require 7 days to fully penetrate the dentin tubules; thus, calcium hydroxide needs to remain in the root canal for at least 7 days. However, long-term intracanal application of calcium hydroxide has been shown to have an adverse effect on the physical and chemical structure of dentin, increasing its fragility and making it prone to fracture by disrupting the connection between the hydroxyapatite and collagen network that lends dentin its flexibility.11 Dentin microhardness has been shown to decrease as a result of long-term use of calcium hydroxide as an intracanal medication,12 with notable changes in fracture-resistance reported if calcium hydroxide is allowed to remain in the canal for more than 10 days.13 In fact, studies have shown that calcium hydroxide cannot be completely removed from root canals with any of a wide range of commonly used devices or techniques,14-17 and it has been suggested that residual calcium hydroxide may reduce the bond strength of fiber posts subsequently applied to root canals.18-20

Ceramics are inorganic, non-metallic materials formed by subjecting raw minerals to high temperatures.21 Bioceramics refer to both biocompatible ceramic materials and metal oxides that possess good sealing, antibacterial and antifungal characteristics, and are used in medicine and dentistry22 for their ability to mimic or induce tissue regeneration.23,24 Bioceramic materials commonly used in endodontic treatment include Mineral Trioxide Aggregate (MTA; ProRoot MTA, Dentsply Tulsa, USA), Biodentine (Septodont, Saint-Maures Fossés, France), BioAggregate (Innovative BioCeramix, Vancouver, BC, Canada) and EndoSequence BC root repair material (Brasseler, Savannah, GA, USA). These materials, which have long been known for their safety when applied to living tissue, are frequently used in root canal treatment for creating an apical barrier and to repair root perforations.25

Teeth with clinical root perforations may also suffer from severe crown destruction, and a variety of post-core systems have been developed to treat these conditions. Although metal posts were used initially, the incompatibility between the elastic modulus of these posts and the surrounding structures were shown to create stress concentrations leading to root fracture, thus prompting the development of posts constructed with different shapes and sizes and from different materials.26 Fiber posts, which have an elastic modulus lower than metal and higher than dentin, have been observed to result in a better distribution of stress26,27 and have been recommended as an alternative to prefabricated and metal posts for restoring teeth that have had previous root-canal treatment28 and possess insufficient remaining crown structure to provide adequate core retention.20 The reduction in stresses transmitted to the root canal walls as a result of the relative similarity between the elasticity modulus of fiber posts and that of dentin reduces the risk of vertical fractures.29 Regardless of post material, stress concentrations are reported to occur mainly at the apical and cervical regions of the tooth, although flexible posts result in stress concentrations in dentin, whereas rigid posts result in stress concentrations at the interfaces between dentin, cement, and post.30 A number of studies have suggested that the distribution of stress can be optimized by using an non-homogenous post design with a functionally graded stiffness that decreases from crown to apex.26,27

Fiber-post failures have been shown to be less destructive than metal-post failures and failure mainly occurs from technical errors that occur during the cementation process. When compared to metal posts, prefabricated fiber posts require a thicker layer of cement.27,31 Despite the interaction between post and dentin produced with the use of resin cement, various bonding failures have been reported,32 and it has been suggested that these failures may be related to the materials used in endodontic treatment, such as calcium hydroxide.33 In addition to intracanal medicaments that change the structure of root-canal dentin, bonding at dentin-cement-post interfaces can also be affected by root-canal irrigation solutions, filling materials, and bioceramics as well as by the preparation of the post space and the presence/thickness of a smear layer.20

Perforation repair materials and their interactions with residual calcium hydroxide used as an intercanal medicament may affect the bond strength of prefabricated fiber posts. This in vitro study compared the effects of four different root-repair materials (MTA, Biodentine, BioAggregate, EndoSequence BC) with and without calcium hydroxide on the bond strength of fiber posts. Bond strength was evaluated using the push-out test. The study’s null hypotheses were as follows: (1) Calcium hydroxide treatment does not affect the bond strength of fiber posts to dentin; and (2) Bioceramics used for root perforation repair do not affect the bond strength between fiber posts and dentin.

Materials and methods

After receiving approval from the Inonu University Non-Interventional Clinical Research Ethics Committee (2017/25-8), this study was conducted with 106 teeth extracted from patients (maximum age: 35) for orthodontic or periodontal reasons. All teeth were caries-free, flat, single-rooted, single-canal mandibular premolars with a root length >14 mm and completed apical development. Periodontal tissue remnants and attachments were removed using a periodontal curette, and the teeth were examined under a digital microscope (RoHS, China) at ×40 magnification to ensure they were free of fractures, cracks, abrasion, erosion and resorption. All teeth were stored in distilled water prior to the experiment.
**Tooth preparation**

Crowns were dissected with a diamond disc under water cooling to obtain roots of 14 mm in length as measured by a caliper. A #10 Type K file was introduced into the root canal, and working length was determined as 1 mm short of its appearance in the apical foramen. Root-canal shaping was completed using iRace rotary files (FKG, La Chaux, Fonds, Switzerland) at 600 RPM and 1.5 Ncm torque, concluding with an R3 (30/.04 dia.) file in line with the manufacturer’s instructions. Root canals were irrigated with 2 ml of 2.5% NaOCl between files and with 2 ml 2.5% NaOCl, 2 ml 17% EDTA, and 2 ml 2.5% NaOCl solutions, respectively and separately, as a final irrigation. Root canals were dried using paper points (DiaDent Europe, Almere, The Netherlands).

An artificial perforation was created in the middle third of each root using a diameter of 2 mm round diamond bur. Teeth were then randomly divided into two groups according to whether or not calcium-hydroxide treatment was performed, and both groups were further divided according to perforation-repair material, as follows (n=11 for experimental subgroups, n=9 for control subgroups):

**Group 1: Samples with Ca(OH)\(_2\) treatment**
- 1a: MTA
- 1b: Biodentine
- 1c: BioAggregate
- 1d: EndoSequence BC Root Repair Material
- 1e: Control Group (root canal treatment and fiber post application without perforation)

**Group 2: Samples without Ca(OH)\(_2\) treatment**
- 2a: MTA
- 2b: Biodentine
- 2c: BioAggregate
- 2d: EndoSequence BC Root Repair Material
- 2e: Control Group (root canal treatment and fiber post application without perforation)

In Group 1, Ca(OH)\(_2\) paste (DiaPaste, DiaDent Europe, Almere, The Netherlands) was placed in the root canal of each tooth using a lentulo spiral, and the teeth were stored at 37°C and 100% humidity for 7 days. The Ca(OH)\(_2\) was then removed from the root canals using ultrasonic tips (DT-009 tip, EMS S.A, Nyon, Switzerland) applied for 2 min under 2.5% NaOCl irrigation. A final irrigation was performed with a sequence of 2 ml 2.5% NaOCl, 2 ml 17% EDTA, 2 ml 2.5% NaOCl, and 2 ml distilled water solutions, and the root canals were dried with paper points.

Root-canal fillings were performed on all teeth using gutta-percha cones and a root-canal sealer. AH Plus sealer (Dentsply DeTrey GmbH, Konstanz Germany) was applied to the apical part of a 30/.04 master gutta-percha cone (DiaDent, Almere, The Netherlands), which was then placed in the canal without touching the perforation area and laterally condensed with 1-2 cones. Since a 30/.04 R3 file was used as the final file for shaping, a 30/.04 master gutta-percha cone was fully compatible with the root canal. After the root-canal filling was completed, the gutta-percha cones were sheared off at the canal orifice using a gutta-cut device (VDW Dental, Munich, Germany). A cotton pellet was placed in the area of the artificial perforation, and zinc phosphate cement was applied as a temporary filling. Teeth were stored at 37°C and 100% humidity for 1 week in order to allow the root-canal sealer to completely set. For all groups except Groups 1e and 2e (control groups), a bioceramic (MTA, BioAggregate, Biodentine, or EndoSequence BC) was applied to the external root surface at the perforation site, and the teeth were stored for 24 h at 37°C and 100% humidity to allow the material to fully set prior to post application.

**Post space preparation and post cementation**

Posts were applied using the Rebilda dual-curing flowable core build-up and post luting system (VOCO, Cuxhaven, Germany) in line with the manufacturers’ instructions. A drill with a diameter of 1 mm was used to create a 9-mm long post space, which was then flushed with 2 ml 17% EDTA followed by 2 ml distilled water and dried with paper points. A fiber post having a diameter of 1 mm was disinfected with alcohol applied using a cotton pellet, and the post was air-dried. An adhesive cement (Ceramic Bond, VOCO, Cuxhaven, Germany) was applied to the post surface and allowed to remain there for 60 s before air-drying, and another adhesive (Futurabond, VOCO, Cuxhaven, Germany) was applied to the root canal and access cavity for 20 s and dried. Rebilda DC was then injected into the root canal using the application tip provided, the post was placed in the filled root canal, and the sample was light-cured for 40 s.

**Push-out test**

Following post cementation, teeth were embedded in transparent orthodontic cold-cure acrylic (Integra, Ankara, Turkey) and sectioned perpendicular to the long axis of the tooth using an IsoMet 1000 (Isomet, Buehler, IL, USA) saw under water-cooling to obtain a sample with a thickness of 2 mm that included the apical and coronal areas to the artificial root perforation. Samples were placed in the push-out test assembly (Figure 1; Autograph desktop model, Shimadzu Corp, Japan) with the apical parts facing up. The cylindrical metal tip (diameter of 0.75 mm) of the testing device was positioned on the center of the fiber post, and a force was applied at a speed of 0.5 mm/min until fracture. Data were recorded in Newtons (N) and...
converted to megapascals (MPa) using the formula: Bond Strength (MPa) = Peak Force (N)/Area (Post-dentin interface area). Post dentin interface area was calculated according to the formula

\[ \pi R_1 R_2 h_1 + (R_2^2 - R_1^2)^{\frac{1}{2}} + h^2, \]

where \( \pi = 3.14, R_1 = \) the diameter of the canal at the coronal part of the section, \( R_2 = \) the diameter of the canal at the apical part of the section, and \( h = \) the height of the section.

Fracture types were examined under a digital microscope (RoHS, China) at ×40 magnification and classified as follows: (a) cohesive fracture within the resin cement or post, (b) adhesive fracture at the cement-post interface, (c) adhesive fracture at the cement-dentin interface, (d) mixed cohesive/adhesive fracture.

Statistical analysis

Data was analyzed using the statistical software package SPSS 22.0 (IBM, Chicago, Illinois, USA) software, and descriptive data ((arithmetic means (mean) ± standard deviations (SD), medians (M), minimums (Min), and maximums (Max)) were recorded. A Shapiro–Wilk test was conducted to determine normality of data distribution, and Kruskal–Wallis, Conover, Unpaired t-tests were applied accordingly, with a level of \( p < 0.05 \) considered statistically significant.

Results

Comparative analysis of the bond strengths of perforation repair materials to fiber posts showed significant differences between the groups \( p < 0.05 \). According to a Conover paired comparison test, the Biodentine (1b) and BioAggregate (1c) subgroups resulted in significantly lower bond strengths \( p = 0.024 \) as compared to the MTA (1a), EndoSequence BC (1d) and control subgroups (1e) when used in conjunction with Ca(OH)\(_2\). In the subgroups tested without Ca(OH)\(_2\), BioAggregate (2c) was found to result in significantly lower bond strengths in comparison to all other subgroups (2a, b, d, e) \( p = 0.039; \) Table 1).

Bond strengths of samples using the same root-perforation material (and control) subgroups with and without Ca(OH)\(_2\) were compared using Kruskal–Wallis and Unpaired t-tests for the BioAggregate subgroups and Mann–Whitney U tests for the remaining subgroups (Table 2). According to the results, calcium hydroxide had no significant effect on bond strength \( p > 0.05 \).

Examination of the samples under a digital microscope at ×40 magnification following push-out testing identified the most common fracture type to be adhesive failure at the dentin-cement interface (Table 3; Figure 2).

Discussion

Artificial communication between the root-canal system and surrounding dental or oral tissue has a negative effect on endodontic treatment and frequently results in treatment failure that requires tooth extraction. The use of a biocompatible material for perforation repair aims to seal the root for preventing leakage and for promoting regeneration of damaged periodontal tissue. Calcium hydroxide is frequently applied in the presence of a perforation. When the material comes into direct contact with vital tissue, a necrotic layer forms that acts as a precursor to mineralization, causing tissue dissolution and creating new granulation tissue that enters the perforation defect to promote wound healing. \(^{34}\)

Conflicting results have been reported regarding the effects of Ca(OH)\(_2\) on the bond strength of fiber posts, with some studies reporting that the intracanal application of calcium hydroxide reduces bond strength, \(^{13}\) others suggest that it increases bond strength, \(^{19}\) and still others suggest that it has no effect \(^{15}\) on bond strength. Both Lee et al. \(^{18}\) and Barbizam et al. \(^{36}\) have stressed the importance of completely removing Ca(OH)\(_2\) from the canal prior to filling, as any

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**Table 1.** Bond strength values of the subgroups (MPa).

| Material              | Min | Max | N  |
|-----------------------|-----|-----|----|
| Calcium hydroxide MTA | 4.70| 3.70| 10.03 | 11 |
| Biodentine            | 4.43| 3.17| 9.65 | 11 |
| Bioaggregate          | 4.18| 3.23| 6.42 | 11 |
| Endosequence          | 5.90| 1.17| 7.50 | 11 |
| Control               | 6.40| 4.92| 7.15 | 9  |
| No calcium hydroxide MTA | 5.67| 3.38| 10.98| 11 |
| Biodentine            | 4.73| 3.10| 8.95 | 11 |
| Bioaggregate          | 4.25| 3.28| 6.60 | 11 |
| Endosequence          | 4.59| 3.75| 8.99 | 11 |
| Control               | 6.63| 4.96| 8.33 | 9  |

\*Different superscript letters in the same column indicate subgroups with statistical differences within that main group \( p < 0.05 \).
residual Ca(OH)₂ may adversely affect the quality of the root filling and subsequent fiber post. According to Someya et al., the observed reductions in bond strength are due to the buffing effect of the alkaline Ca(OH)₂ on the etching components and acidic monomers in the adhesive systems. In fact, the removal of residual calcium hydroxide from irregular canal walls is fairly difficult. Although various techniques have been proposed, including endodontic hand files, sonic activation, passive ultrasonic irrigation, a canal-brush system and nickel-titanium (NiTi) rotary files, none of these methods have been shown to be capable of completely removing Ca(OH)₂ from root canals. Our study’s overall finding that the application of calcium hydroxide did not affect the bond strength of fiber posts (p > 0.05) may be due to our use of passive ultrasonic irrigation with sodium hypochlorite agitation following calcium hydroxide treatment to remove any residual reagent that might affect the adhesive system.

In our study, MTA had no significant effect on the bond strengths between fiber posts and dentin (p > 0.05). This finding conflicts with a study by Pereira et al. which reported that MTA used for perforation repair in the cervical region of the root canal reduced the bond strength of fiber posts. The authors suggested that the bonding of fiber posts was negatively affected by the reduced area of dentin at the adhesive interface as a result of the root perforation as well as contamination of the dentin adjacent to the perforation area with MTA. The difference in findings between studies may be due to differences in cementation procedures. Whereas Pereira et al. performed cementation of fiber posts immediately after MTA application, in our study, cementation was performed 24h after application of MTA, which has a mean setting time of 140 ± 3m. By allowing the MTA to set completely, the possibility of any unset MTA particles contaminating the resin cement and affecting bond strength was eliminated.

| Table 2. Comparison of bond strengths of Ca(OH)₂ and non-Ca(OH)₂ subgroups. |
|-----------------------------|---|---|---|---|
|                             | M | Min | Max | p  |
| MTA and Ca(OH)₂            | 4.70 | 3.70 | 10.03 | 0.622x |
| MTA                        | 5.67 | 3.38 | 10.98 |  |
| Biodentine and Ca(OH)₂     | 4.43 | 3.17 | 9.65 | 0.670x |
| Biodentine                 | 4.73 | 3.10 | 8.95 |  |
| Bioaggregate and Ca(OH)₂   | 4.25 | 3.28 | 6.60 | 0.870y |
| Bioaggregate               | 4.18 | 3.23 | 6.42 |  |
| Endosequence and Ca(OH)₂   | 5.90 | 1.17 | 7.50 | 0.341x |
| Endosequence               | 4.59 | 3.75 | 8.99 |  |
| Ca(OH)₂ control group      | 6.40 | 4.92 | 7.15 | 0.227x |
| Control group without Ca(OH)₂ | 6.63 | 4.96 | 8.33 |  |

Different superscript letters in the same column indicate the different type of statistical analysis applied.

xPaired comparison of the groups was performed using the Mann–Whitney U test, since the groups here show normal distribution.
yPaired comparison of BioAggregate groups was performed using the Unpaired t test, since the groups here did not show normal distribution.

| Table 3. Classification of fracture types following push-out testing. |
|-----------------------------|---|---|---|
| Cohesive | Adhesive | Mix |
| Resin cement | Resin cement-post (Type b) | Resin cement-dentin (Type c) | (Type d) |
| Post (Type a) | 2 (2.12%) | 4 (4.24%) | 2 (2.12%) | 3 (3.18%) |
| MTA | 4 (4.24%) | 5 (5.30%) | 2 (2.12%) |
| Biodentine | 3 (3.18%) | 5 (5.30%) | 3 (3.18%) |
| Bioaggregate | 3 (3.18%) | 5 (5.30%) | 3 (3.18%) |
| Endosequence | 4 (4.24%) | 5 (5.30%) | 1 (1.06%) |
| Control | 1 (1.06%) | 1 (1.06%) | 1 (1.06%) |
| No calcium hydroxide | | | |
| MTA | 4 (4.24%) | 5 (5.30%) | 2 (2.12%) |
| Biodentine | 3 (3.18%) | 3 (3.18%) | 3 (3.18%) |
| Bioaggregate | 5 (5.30%) | 5 (5.30%) | 1 (1.06%) |
| Endosequence | 4 (4.24%) | 3 (3.18%) | 2 (2.12%) |
| Control | 1 (1.06%) | 2 (2.12%) | - |
| Total | 8 (8.48%) | 32 (33.92%) | 36 (38.16%) | 18 (19.08%) |

In our study, MTA had no significant effect on the bond strengths between fiber posts and dentin (p > 0.05). This finding conflicts with a study by Pereira et al. which reported that MTA used for perforation repair in the cervical region of the root canal reduced the bond strength of fiber posts. The authors suggested that the bonding of fiber posts was negatively affected by the reduced area of dentin at the adhesive interface as a result of the root perforation as well as contamination of the dentin adjacent to the perforation area with MTA. The difference in findings between studies may be due to differences in cementation procedures. Whereas Pereira et al. performed cementation of fiber posts immediately after MTA application, in our study, cementation was performed 24h after application of MTA, which has a mean setting time of 140 ± 3m. By allowing the MTA to set completely, the possibility of any unset MTA particles contaminating the resin cement and affecting bond strength was eliminated.
Our study found that the fiber posts in the Biodentine subgroups had lower bond strengths when compared to the other subgroups; however, the difference was only significant for the group treated with Ca(OH)₂ ($p=0.024$). Meraji and Camilleri⁴² found that acid-etching produced micromechanical and chemical changes in the structure of Biodentine and that these changes were more pronounced with self-etch systems than with total-etch systems, creating areas of irregularity in the Biodentine surface.⁴² Considering that our study used a self-etch adhesive system for bonding, it may be suggested that the observed reduction of the bond strength of the fiber posts used in teeth repaired with Biodentine was due to a deterioration in the material structure resulting from the processes occurring within the adhesive cement applied prior to bonding.

Our study also showed the bond strength of fiber posts in samples repaired with BioAggregate to be lower in comparison to other repair materials, regardless of whether or not calcium hydroxide was used ($p<0.05$). According to Camilleri et al.,⁴³ BioAggregate powder has a specific surface area higher than that of ProRoot MTA and a high degree of internal porosity due to the presence of calcium silicate, as seen in scanning electron microscope examination. The authors stated that because of the high specific surface area and internal porosity, BioAggregate requires more water to obtain an adequate mixture, and this high water-to-powder ratio results in a high material porosity and poor physical properties and subsequent poor bond strength and material deterioration. Accordingly, the low bond strength of fiber posts found in our study when root repair was performed using BioAggregate may be explained by deterioration in the material structure.

To our knowledge, there is no study in the literature evaluating the effect of EndoSequence BC root-repair material on the bond strength of fiber posts. In our study, EndoSequence BC root-repair material was found to have no significant effect on the bond strength of fiber posts ($p>0.05$).

In view of the above findings, the study’s first null hypothesis, which suggests that calcium hydroxide treatment does not affect the bond strength of fiber posts, was accepted ($p>0.05$; Table 2). However, the study’s second

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Figure 2. Four fracture types: (a) cohesive fracture within post, (b) adhesive fracture between resin cement-post, (c) adhesive fracture between resin cement-dentin, and (d) mixed cohesive/adhesive fracture.
null hypothesis, which suggests that the bond strength of fiber posts is not affected by the bioceramics used for root perforation repair, was rejected, as the bond strength of fiber posts was reduced in the Biodentine/Ca(OH)$_2$ subgroup and in both BioAggregate subgroups ($p < 0.05$).

Digital microscope examination of bond failures in the present study showed most failures were characterized by adhesive failure between the dentin and resin cement, which is in line with findings of previous studies conducted by Teixeria$^{44}$ and Kececi et al.$^{45}$ In our study, only 8 out of 106 fractures were due to cohesive failure of the fiber posts. Whereas post cohesive fractures indicate that the bonding between both cement and dentin and cement and post is better than the stability of the post itself,$^{46}$ adhesive failure at the cement-post interface is thought to occur due to an insufficient chemical bond between the resin cement and fiber post.

**Conclusion**

- Calcium hydroxide treatment does not affect the bond strength of fiber posts and, accordingly, can be used as an intracanal medicament when necessary in teeth requiring a fiber post for restoration.
- The choice of either MTA or EndoSequence BC to repair root perforations offers a mechanically successful approach in teeth requiring subsequent treatment with a fiber post.
- Digital microscope examination of fiber-post bond failure showing the majority of failures to occur within the root canal at the dentin-resin cement interface is an indication that the bond formed between fiber posts and resin cement is stronger than the bond formed between cement and dentin.

**Author Note**

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**Declaration of conflicting interests**

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