

# Stereomicroscopic Evaluation of Fiber Post Failure Modes after Use of Three Different Endodontic Sealers: An *In Vitro* Study

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## ABSTRACT

**Aim and objective:** The aim and objective of this study was to evaluate the three different root canal sealers that influenced the failure modes of fiber post luted with self-adhesive resin cement. Under a stereomicroscope, the influence of three different endodontic sealers on the failure modes of fiber post luted with self-adhesive resin cement was evaluated and compared.

**Materials and methods:** In this study, 45 mandibular premolars were tested. To standardize the root length, the samples were decoronated at the cemento-enamel junction. Working length was determined using the Ingles method. The samples were separated into three groups after cleaning and shaping, and each group was obturated with gutta-percha and the respective sealer. For 1 week, all of the samples were incubated at 37°C. Drills given by the manufacturer were used to prepare the post area, and the appropriate post was luted with self-adhesive resin cement. The samples were incubated at 37°C for 1 week. Following that, the samples were sectioned into 2-mm-thick slices at the coronal, middle, and apical levels. The universal testing machine was used to execute the push-out test, and the mode of failure was investigated under a stereomicroscope.

**Result:** Bio-C sealer group showed maximum mixed failure. Maximum cohesive failure was observed in the AH Plus group, and maximum adhesive failure was observed in the mineral trioxide aggregate (MTA) Fillapex group.

**Conclusion:** The group where the Bio-C sealer was used showed more amounts of mixed failure and better bond strength in comparison with AH Plus sealer and MTA Fillapex sealer.

**Keywords:** Bond strength, Endodontic sealer, Fiber post, Resin cement.

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## INTRODUCTION

The selection of an appropriate repair for natural function and esthetic rehabilitation in compromised teeth is a key problem.<sup>1</sup> When the crown is clinically close to being damaged, intraradicular posts are recommended to provide retention between the prosthetic crown and the remaining tooth structure.<sup>2,3</sup> This retention is critical to the long-term longevity of the ultimate repair.<sup>4</sup>

Fiber-reinforced composite posts have seen increased use in recent years<sup>5</sup> because of advantages such as acceptable aesthetics, a modulus of elasticity similar to dentin, stress dispersion across a wider surface area on root canal walls, and a minimal risk of vertical root fracture.<sup>6,7</sup> However, a variety of circumstances have been observed to obstruct the bonding of fiber posts to root dentin. The type of root canal sealer used during obturation is one of these variables.

Root canal sealers that have traditionally been used include zinc oxide eugenol, calcium hydroxide, and resin-based sealers. Newer root canal sealers are currently being developed to overcome the drawback of existing sealers.<sup>8</sup>

Bioceramics are ceramic materials used to treat and replace severely ill musculoskeletal system components. Bio-C sealer, a calcium silicate-based sealer, was developed as a new generation endodontic sealer and is available in both premixed paste and powder liquid forms. Zirconium oxide, calcium silicates, calcium phosphate monobase, calcium hydroxide, and thickening agents were also present.<sup>9</sup>

Mineral trioxide aggregate (MTA) Fillapex is a sealer based on MTA. MTA Fillapex is a sealer that composed of MTA, salicylate

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resin, natural resin, bismuth oxide and silica. It is biocompatible and radiopaque, stimulates mineralization, also releases calcium ions, and exhibits good adhesive properties to dentin as well as sealing ability comparable to epoxy resin-based sealers.<sup>10</sup>

AH Plus is a two-component epoxy-amine resin-based paste/paste root canal sealant. AH Plus is a hydrophobic epoxy resin-based sealer that has been considered as a gold standard in sealer comparisons. In this study, it has been used as a reference material for comparison.<sup>11</sup> This study aims at determining the effect of MTA

Fillapex and Bio-C sealers on the bonding efficacy of fiber post to radicular dentin.

The null hypothesis was that there would be no difference in the failure mode of fiber post luted with self-adhesive resin cement between these three different root canal sealers.

## AIM AND OBJECTIVE

The aim of this study was to evaluate the three different root canal sealers that influenced the failure modes of fiber post luted with self-adhesive resin cement.

The objective of this study was to use a stereomicroscope to evaluate and compare the failure modes of fiber post luted with self-adhesive resin cement after using three different endodontic sealers.

## MATERIALS AND METHODS

### Ethical Clearance

A protocol explaining the study's goal and procedures was submitted to the Institutional Review Board of Vivekanandha Dental College for Women and the study was approved.

### Methodology

This study included 45 mandibular single-rooted premolars with mature apices extracted for therapeutic reasons. Cracked, carious, restored, or fractured roots were eliminated from the study. The samples were then stored in normal saline after being decoronated at the cemento-enamel junction to standardize the root length. A size 10 stainless steel endodontic K-file was used to negotiate the root canal until the tip of the file was seen at the apical foramen. Radiographs were taken to confirm the working length, which was calculated by subtracting 1 mm from the initial length. Using ProTaper Gold rotary files, all of the canals were instrumented to the working length.

Throughout instrumentation, canals were irrigated with a 3% sodium hypochlorite solution and normal saline. For the final irrigation, 5 mL of 17% ethylenediaminetetraacetic acid was used for 1 minute, followed by 5 mL of normal saline. Following that, the samples were stored in normal saline and separated into three groups of 15 specimens each, based on the sealer used:

- MTA Fillapex (Angelus) in group I
- AH Plus (Dentsply) in group II, and
- Bio-C (Angelus) in group III.

The sealer was mixed and injected into the canal using a self-mixing tip attached to a syringe provided by the manufacturer in group I (MTA Fillapex). The canal was then sealed with MTA Fillapex sealer and a size 25/0.06 GP cone was inserted until the working length was obtained. At orifice level, the remaining gutta-percha was sheared off.

The AH Plus sealer was mixed on a paper pad in group II (AH Plus). A gutta-percha cone with a #25/0.06 taper was coated with AH Plus sealer and pumped into the root canal a few times. The cone was taken out, resealed, and reinserted up to the working length. At orifice level, the remaining gutta-percha was sheared off.

The premixed bioceramic sealer is put into the canal with the syringe tip provided by the manufacturer in group III (Bio-C sealer). The sealer-coated gutta-percha was introduced into the root canal until it reached the working length, after which the remaining gutta-percha was sheared off at the orifice level.

Temporary cement was used to seal the coronal parts of canals (Cavit). For 1 week, all of the samples were incubated at

37°C. Drills provided by the manufacturer were used to prepare the post space to a length of 10 mm. The root canals were cleaned with distilled water, then dried with paper points before being luted with self-adhesive resin cement (Multilink). The samples were kept at 37°C for another week. Following that, the samples were cut into 2-mL slices at the coronal, middle, and apical thirds of the post length.

A universal testing machine with a crosshead speed of 1 mm/minute was used to perform the push-out test on each specimen. The plunger used to have a diameter that was around (at least) 80% of the canal's diameter. Each specimen was examined under a stereomicroscope at a magnification of 40 times to determine the failure mode.

### Statistical Analysis

The data were statistically examined using SPSS software version 18.0, and the groups were compared using the Chi-square test.

## RESULT

Figure 1 showed that intergroup comparison of modes of failures among three groups are represented by bar graph.

Adhesive failure was seen mostly in MTA Fillapex sealer (group I) when compared to AH Plus (group II) and Bio-C sealers (group III).

Cohesive failure was seen mostly in AH Plus sealer (group II) when compared to MTA Fillapex (group I) and Bio-C sealers (group III) sealers.

Mixed failure was seen mostly in Bio-C sealer (group III) when compared to MTA Fillapex (group I) and AH Plus (group II) sealers.

Table 1 shows that 60% of adhesive failures is more in MTA Fillapex when compared with AH Plus and Bio-C sealer.

53% of Cohesive failures is more in AH plus when compared with MTA Fillapex and Bio C sealer.

53% of Mixed failures is more in Bio-C when compared with MTA Fillapex and AH Plus sealer. The statistical significance level was set at  $<p 0.01$ .

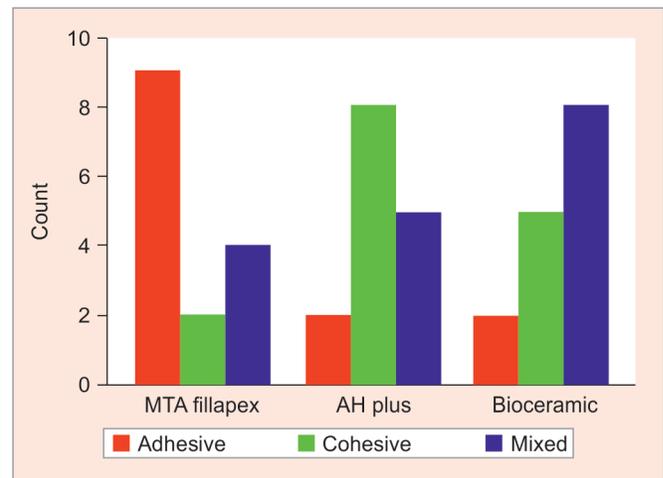


Fig. 1: Intergroup comparison of modes of failure among three groups

## DISCUSSION

Endodontic therapy aims to not only clean and shape the root canal to remove bacteria but also to assure that the root canal system

**Table 1:** Mean value for the modes of failure among three groups using Chi-square test

Group	Coronal						Total	Chi-square	p
	Adhesive		Cohesive		Mixed				
	N	%	N	%	N	%			
MTA Fillapex	9	60.00	2	13.33	4	26.67	15	12.67	0.013*
AH Plus	2	13.33	8	53.33	5	33.33	15		
Bioceramic	2	13.33	5	33.33	8	53.33	15		
Total	13	28.89	15	33.33	17	37.78	45		

closes fluid tightly. Sealers have been considered essential since gutta-percha adheres poorly to canal walls. The main purpose of a root canal sealer is to fill up defects and improve the root filling material's adaptability to the canal walls.<sup>12-15</sup>

However, in teeth with significant coronal tooth structure loss, intraradicular posts may be necessary for final restorative support and retention.

Due to benefits like the ability to bind to the tooth structure, a modulus of elasticity similar to dentin, and enhanced aesthetics, prefabricated glass-fiber-reinforced composite posts have been popular in recent years. Fiber post cementing can be done with either traditional dual-cured resin cement or self-adhesive resin cement. Fiber posts cemented using self-adhesive resin cement have been found to have similar retention to posts cemented with traditional dual-cured resin cement.<sup>16-19</sup>

According to several studies, sealers have an effect on the bonding efficiency of fiber post luted to the root dentin with self-adhesive resin cement. As a result, we examined the bonding efficiency of self-adhesive resin cement with root dentin after using three different endodontic sealers in this study.

The push-out test simulates clinical conditions by applying shearing force to the dentin-post-cement surfaces. Because there is no premature failure, the push-out test offers a more adequate evaluation of resistance to dislodgment.<sup>20</sup>

The following criteria were used to categorize the failure modes:

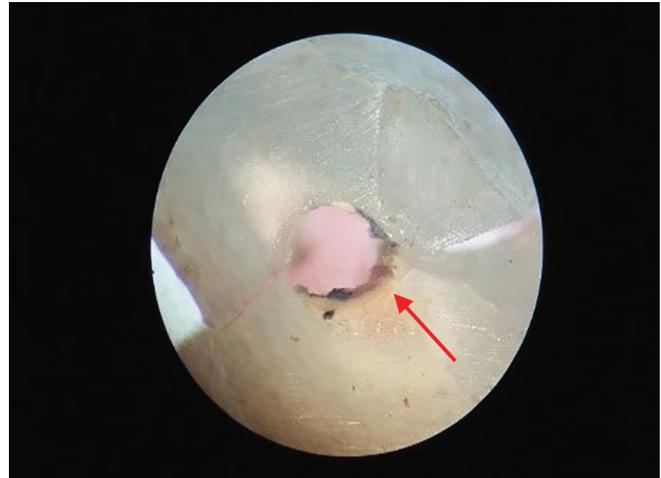
Type I—Adhesive failure between dentin and resin cement. (Fig. 2)

Type II—Cohesive failure inside the dentin or within the cement. (Fig. 3)

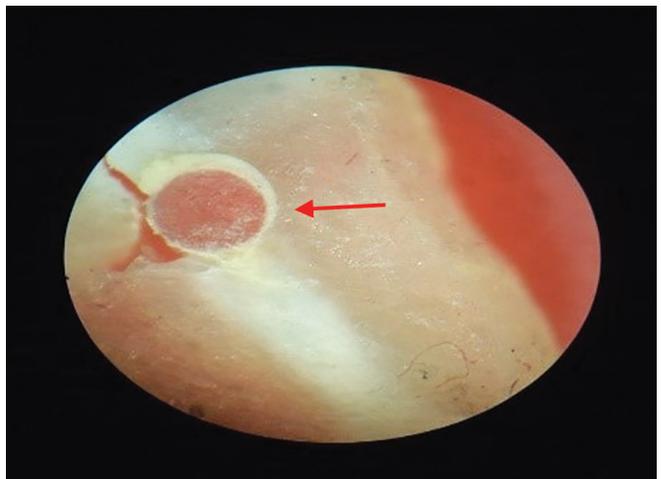
Type III—Mixed failures, in which the sample showed both adhesive and cohesive failure.<sup>21</sup> (Fig. 4)

The AH Plus sealer is an epoxy-bisphenol resin-based sealer made up of epoxy resin and amines. The epoxy resin interacts with the dentin collagen, creating a covalent bond with it, increasing the bond strength of this sealer to the root dentin. It has greater penetration into the microdefects in radicular dentin due to its flowability, creep capacity, and longer setting time, which enhances mechanical interlocking between sealer and root dentin.

The resin luting cement used in this study, Multilink, is a combination of hydrophilic and hydrophobic monomers. The later molecules will give hydrophobic characteristics, which are necessary to manage the moisture state of dentin and prevent the absorption of excess water, which might inhibit the polymerization process of the material; as a result, it will bind effectively with the epoxy resin-based sealer.<sup>22</sup>



**Fig. 2:** Adhesive failure



**Fig. 3:** Cohesive failure

Cohen et al. found that epoxy resin in the composition of resin-based cement such as AH Plus did not interfere with free radical activation in composite resin. As a result, resin-based sealers have no reversible action on resin cement adherence.<sup>23</sup>

According to Forough Reyhani et al., the greater bond strength of resin-based sealers is due to better and more homogeneous

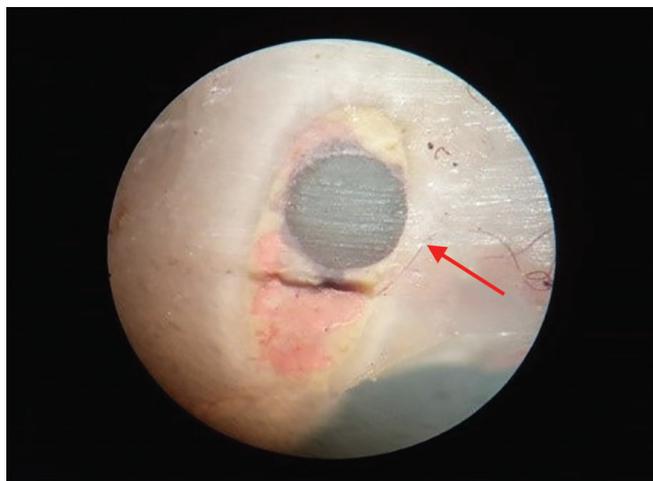


Fig. 4: Mixed failure

penetration into dentinal tubules and bonding with collagen matrix.<sup>24</sup>

The failure mode most commonly seen in the AH Plus group was cohesive in character, which is similar to the findings of Eldeniz et al.,<sup>25</sup> Shokouhinejad et al.,<sup>26</sup> and Vilanova et al.<sup>27</sup>

Bio-C sealer is a calcium phosphate, calcium silicate, zirconium oxide, and calcium hydroxide-based insoluble, radiopaque, and aluminum-free substance.<sup>28</sup> Calcium phosphate improves bioceramic setting characteristics and results in a chemical composition and crystalline structure comparable to that of tooth and bone apatite materials, increasing sealer-to-root dentin bonding. Mechanical interlocking connections are formed as the sealer particles diffuse into the dentinal tubules.

The mineral content of the sealer infiltrates the intertubular dentin, resulting in the formation of a mineral interaction zone produced after denaturing the collagen fibers with a strong alkaline sealer. There is little to no information on the effect of Bio-C sealer on the failure mode of fiber posts luted with self-adhesive resin cement.

The current study found that the Bio-C sealer group had more mixed type failures than the other two groups, suggesting that the Bio-C sealer had no effect on the bonding of fiber post to radicular dentin; however, additional research is needed to prove this.

It is made of monobasic calcium phosphate, which facilitates the reaction with calcium hydroxide to produce water and hydroxyapatite when the sealer is activated by water. Hydroxyapatite coprecipitates with calcium silicate hydrate to form a composite-like structure that reinforces the set cement.<sup>29</sup>

Furthermore, the nanofiller in this sealer can improve bond strength. As a result, including nanosize fillers into root sealers is recommended to enhance bonding between the sealer and the root dentine. As a result, the BC sealer group has a higher rate of mixed failure than the other two groups.<sup>30</sup>

MTA Fillapex is a root canal sealant based on MTA and salicylate resin. It is aimed to have a high-flow rate and a thin film thickness to allow for easy penetration into lateral and accessory canals. The bond strength of MTA Fillapex is significantly smaller than that of AH Plus and Bio-C sealer.

The lower bond strength of MTA Fillapex can be explained by the higher percentage of gap-containing regions observed due to MTA

Fillapex lower adaptation to canal walls because sealers containing salicylate in the composition exhibit initial volumetric shrinkage during the setting reaction, increasing the contraction factor. On the contrary, epoxy resin sealers (AH Plus) are considered to have low contraction factor and some degree of expansion during the setting reaction as in EndoSequence BC sealer. The resin content in MTA Fillapex sealer is less as compared to AH Plus, which might also be one of the reasons why MTA Fillapex showed more number of adhesive failures as compared to the other two groups.<sup>31,32</sup>

## CONCLUSION

The current study, as well as earlier studies, shows that sealers have an effect on the bond strength of the self-adhesive resin cement used to bind fiber post to radicular dentin. As a result, it is essential to select a sealer that will not interfere with the bond strength of the fiber post luted to the radicular dentin when using self-adhesive resin cement.

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