

# Effect of different endodontic sealers on push-out bond strength of fiber posts

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## Abstract

Despite the increasing demand for fiber-reinforced composite (FRC) posts, their bonding to root canals is still subject to debate. Endodontic sealers may affect the bond strength between fiber posts and root canal dentin. **Aim:** To compare the effects of different sealers on fiber post bond strength. **Methods:** Sixty teeth were divided into 4 groups according to obturation method: GI, gutta-percha without any sealers; GII, gutta-percha and AH26 resin-based sealer; GIII, RealSeal point and RealSeal resin-based sealer, GIV, Guttaflow. Fiber posts were cemented into root canals. Specimens were sectioned, and the bond strength was measured in the middle area. The failure mode was evaluated. Data were analyzed by one-way ANOVA and *post hoc* test. **Results:** The highest bond strength was observed in the control group ( $2.95 \pm 1.12$ ), and the least was in the Guttaflow group ( $1.15 \pm 0.78$ ). There was a significant difference between bond strengths of the control and Guttaflow groups and between AH26 and Guttaflow groups ( $p < 0.05$ ). The failure mode was mainly adhesive between dentin and resin cement in all groups. **Conclusions:** Sealers may have a negative effect on the bond strength of fiber posts to root canal dentin.

**Keywords:** root canal filling materials; dentin; dental pulp; tooth; root canal obturation.

## Introduction

The selection of a proper type of restoration for natural function and esthetic rehabilitation is a major concern in weakened teeth<sup>1</sup>. When the crown is clinically almost destroyed, intraradicular posts are indicated to secure retention between the prosthetic crown and the remaining tooth structure<sup>2-3</sup>. This retention plays an important role in the durability of the final restoration<sup>4</sup>.

Recent years have seen increased utilization of fiber-reinforced composite (FRC) posts<sup>5</sup> because of their advantages of desirable esthetics<sup>6</sup>, a modulus of elasticity similar to dentin, stress distribution along a wider surface area on root walls, and minimal risk of vertical root fracture<sup>7-8</sup>.

Relating to the limitations in bonding to root canal dentin, numerous studies have been conducted to improve bonding of posts to tooth structures<sup>9</sup>. Endodontic sealers are among the factors that may have a negative influence on post retention inside the canal<sup>2,10</sup>.

Endodontic sealers should seal the canal laterally and apically and have acceptable adaptation to the root canal dentin<sup>11</sup>. There is a growing interest in the utilization of resin-based sealers that bond simultaneously to core material and the canal wall, creating a monoblock<sup>12</sup>. These sealers often have the ability to penetrate lateral canals, accessory canals and dentinal tubules<sup>11</sup>. Consequently, it appears that they cannot be removed completely after canal preparation, which

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can adversely affect the bond strength between posts and root canal dentin<sup>13</sup>.

Guttaflow is a new type of siloxine-based sealer that contains two products in one system: gutta-percha particles (less than 30 µm) and polydimethylsiloxine sealer. This injection system has no gutta-percha shrinkage and exhibits only minor expansion during setting because of the cold filling system and absence of heat. Furthermore, removal of this filling material in cases of endodontic re-treatment or preparation of post space would be easier<sup>14</sup>.

This study aimed to assess the effects of two resin-based sealers and Guttaflow on the bond strength of fiber posts. We hypothesized that Guttaflow would have less effect on the bond strength of fiber posts because there is no chemical bond with radicular dentin.

## Material and methods

Sixty human anterior maxillary teeth, extracted because of periodontal problems over a period of 3 months were collected. Informed consent was obtained from patients (ethical approval number 16897). Roots were free of caries, cracks or resorption. Teeth were stored in 0.5% chloramine T solution for 1 week and then stored in distilled water. The clinical crowns were sectioned transversely 1 mm up to the cemento-enamel junction, with a low-speed diamond disk with air-water cooling (Isomet 2000; Buehler Ltd, Lake Bluff, IL, USA). Working length of the remaining roots was measured by the direct method, subtracting 1 mm from the apex by means of a #10 K file. Biomechanical preparation was performed with rotary instruments of the Mtwo system (VDW GmbH, Munich, Germany). The apical preparation was extended until #35. The canal was irrigated with 2% chlorhexidine during instrumentation.

The teeth were randomly divided into 4 experimental groups (n=15) according to the type of sealer used during the canal filling:

GI: Control group: Teeth were filled with gutta-percha (Coltène/Whaledent, Langenau, Germany) without any sealer, by the lateral condensation technique.

GII: AH26 group: Teeth were filled with AH26 sealer (Dentsply DeTrey GmbH, Konstanz, Germany) and gutta-percha by the lateral condensation technique. Root canals were irrigated with 2% chlorhexidine and dried with absorbent paper points. Sealer was introduced into canals by lentulo spirals.

GIII: RealSeal group: Teeth were filled with RealSeal sealer (SybronEndo, Orange, CA, USA) and RealSeal point. Root canals were irrigated with sodium hypochlorite and dried. Smear layers were eliminated with 17% EDTA (SmearClear, SybronEndo, Orange, CA, USA). Canals were then irrigated with 2% chlorhexidine and dried with #30 paperpoints (VDW, Munich, Germany). Two pastes of RealSeal were mixed and introduced into canals by lentulo spirals. Filling was completed with RealSeal point by the lateral condensation technique. Teeth were light-cured with a LAVA led unit (Ultradent Products Inc., South Jordan, UT,

USA) (1000 mW/cm<sup>2</sup>), for 40 s, from the coronal direction.

GIV: Guttaflow group: Teeth were filled with the Guttaflow system (Coltène/Whaledent, Langenau, Germany). Root canals were irrigated with chlorhexidine and dried with paperpoints. A Guttaflow capsule was then mixed and injected into the canal, and a single gutta-percha cone was inserted into the canal according to the manufacturer's instructions.

After the filling was complete, coronal portions of canals were sealed with temporary cement (Cavit G; 3M ESPE, Seefeld, Germany). The specimens were kept in 100% humidity for one week at 37 °C. Post space was prepared with Gates-Glidden burs #2 to #4 (Dentsply Maillefer) at 10-mm length. The root canals were washed with distilled water, then dried. Fiber glass posts (Angelus, Londrina, PR, Brazil) were cemented by the Panavia F2.0 system, and light-cured for 20 sec with a LAVA LED unit (Ultradent Products Inc.) (1000 mW/cm<sup>2</sup>).

Samples were then mounted in transparent acrylic resin and sectioned with a cutting device and diamond-covered disc (Mecatome, Presi, France) in 1-mm slices, by a high-speed sectioning machine. Sections were perpendicular to the long axis of the tooth, and the third and fourth sections were selected. The specimens were fixed in a universal testing machine (Zwick, Ulm, Germany), and the push-out test was done at a cross-head speed of 0.5 mm/min, from the apical direction. The plunger was selected according to root canal diameter, which was measured by AutoCAD software 2006; the plunger was between 80 and 90% of canal diameter. It was positioned to touch only the post, without contact with the root canal dentin. The applied force that dislodged the post and cement from the root canal was recorded. The unit of this force was  $A = \pi(R + r)(h^2 + (R - r)^2)^{0.5}$  for conversion into megapascal, in which R represents the root canal radius in the coronal portion, r represents the root canal radius in the apical portion, and h represent the height of specimen slices. Root canal radius was measured with AutoCAD software 2006.

After the push-out test, the failure mode was evaluated by stereomicroscopy (Nikon type 102, Nikon Corp., Tokyo, Japan) at 40x magnification. Failure classification was cohesive if more than 75%, and adhesive if less than 25%, of the luting resin remained on the tooth surface.

Means and standard deviations were compared by one-way ANOVA and *post hoc* tests with SPSS software Ver. 16. Statistical significance was set at 0.05 for all analyses.

## Results

Bond strength results of the experimental groups are in Table 1. According to these results, the maximum bond strength was observed in the control group (2.95 ± 1.12), with the minimum bond strength in the Guttaflow group (1.15 ± 0.78). AH26 group bond strength data (2.68 ± 0.90) are closer to the control group than the RealSeal group.

One-way ANOVA of the data showed significant differences between groups (p < 0.05). The *post hoc* analysis

**Table 1:** Statistical specifications of bond strength of fiber post in the experimental groups

Experimental Groups	Mean±SD	Minimum	Maximum
Control	2.95±1.12 <sup>a</sup>	1.23	5.24
AH26	2.68±0.90 <sup>a</sup>	1.38	4.64
Realseal	2.02±1.27 <sup>a</sup>	0.29	4.58
Guttaflow	1.15±0.78 <sup>b</sup>	0.07	2.64

Different letters represent the statistical differences between the groups

of data showed that the control group had the highest bond strength and the Guttaflow group had the lowest bond strength (Figure 1).

Significant differences were observed between the fiber post bond strengths of the control and Guttaflow groups, and between AH26 and Guttaflow groups ( $p < 0.05$ ). In both comparisons, the bond strength of Guttaflow was less than the other groups.

Failure mode distribution can be observed in Table 2. Adhesive failure (between cement and dentin) was the most common failure in all groups.

**Table 2:** Failure mode distribution in the groups (%)

Sealer	Adhesive (cement and dentin)	Cohesive	Adhesive (cement and post)
AH26	54	22.7	22.7
Control	58	25	17
RealSeal	86.3	9	4.5
GuttaFlow	91.6	4.5	4.5

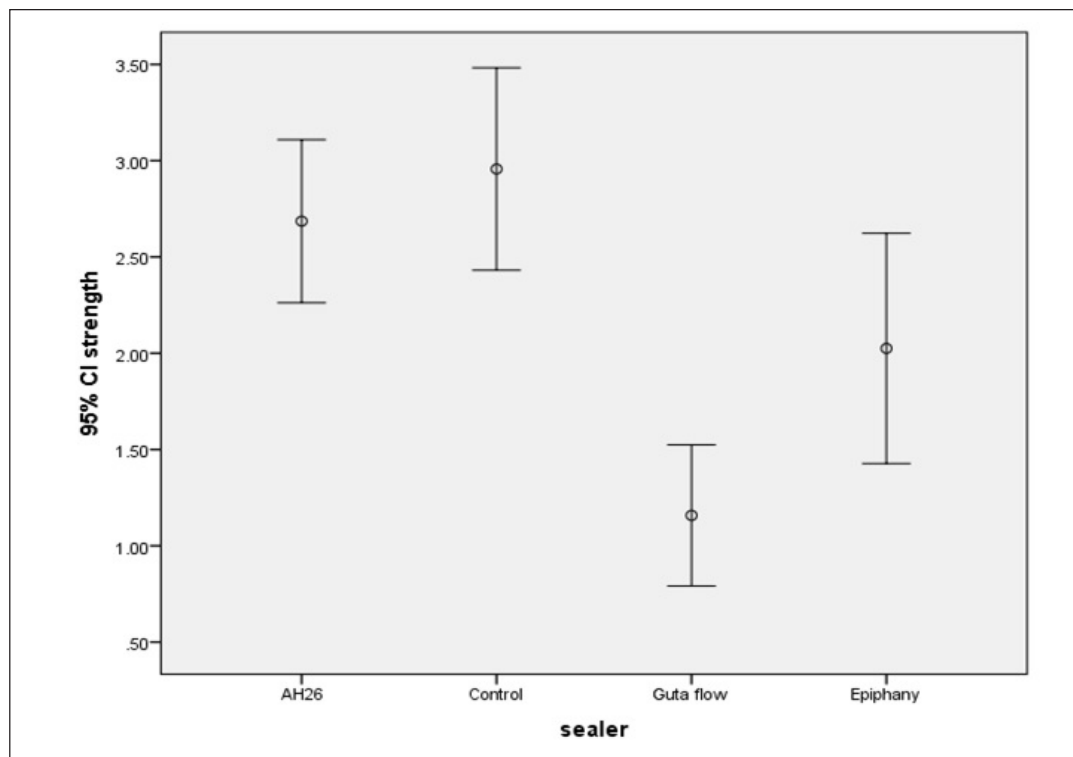
## Discussion

One of the major problems of fiber posts is dislodgement of the post from the root canal. Posts are placed in spaces prepared by the removal of filling material without encroaching on the apical portion, then bonded to tooth structures with adhesive cements. The success of fiber posts depends directly upon the quality of bonding among the fiber post/cement/root canal dentin<sup>15-16</sup>. Both non-post-related factors, such as type of cement, irrigation solution during root canal preparation and type of sealer, and post-related factors, such as length, diameter, surface and design of the post may affect retention of the fiber post to the root canal walls<sup>17-18</sup>.

Resin-based cements play an important role in the durability of fiber posts. Concerning the limitations of the root canal structure, self-etch resin-based luting cements are utilized to bond fiber posts to overcome problems of wet-bonding in total-etch systems<sup>16,19</sup>. The bond would be formed with superficial layers of dentin in self-etch system via smear layer<sup>19</sup>.

Concerning root canal wall modification made by endodontic sealers and canal filling materials, it seems that these materials affect the bond between post and canal walls<sup>15-16,20</sup>.

Resinous sealers have the ability to penetrate lateral canals, accessory canals, and dentinal tubules<sup>7</sup>, and their composition and depth of penetration can have specific effects in reducing the post bond strength<sup>16</sup>. These filled dentinal tubules may be obstructed while post spaces are being prepared, which would interfere with the formation of a hybrid layer of resin cement and dentin.

**Fig. 1.** One way ANOVA analysis for comparison of fiber post bond strength among experimental groups.

The present study assessed the effect of three types of sealers on bond strength of fiber posts. The effect of each sealer on the bond strength of fiber posts was evaluated by a thin-slice push-out test, which requires 1-mm-thick root disks<sup>21</sup>. Plunger size diameter was chosen according to root canal diameter. This method results in more reliable, reproducible and clinic-like conditions than other tests<sup>22</sup>. This study evaluated the bond strength at the middle third using two serial sections, because other studies reported that the portion of the root canal to have a significant effect on the bond strength of fiber posts<sup>23-24</sup>.

Results indicated that Guttaflow would significantly reduce the fiber post bond strength, in comparison with the control group or the AH26 group. The guttaflow group showed a significant difference from the control group. The highest bond strength was observed in the control group, which lacked any kind of sealer, which agrees with the results of other studies<sup>15-16,20</sup>. This could be explained by the absence of sealers, whereby cement penetration into root dentin was at the highest level<sup>7</sup>.

According to the results of the present study, it may be observed that while the bond strength is decreasing among the sealer groups, the prevalence of adhesive failure mode between dentin and cement is simultaneously rising (Table 2). The lowest bond strength was obtained by the Guttaflow group, with the highest occurrence (91.6% of samples) of adhesive failure.

The AH26 group showed the highest bond strength among the experimental groups, followed by the RealSeal group. The lack of significant differences confirms the results of some studies<sup>7</sup>, but is in contrast with the results of Demiryurek et al.<sup>16</sup>. This difference may be due to the use of special post drills, which would result in a clean canal surface with high post adaptation, a procedure that would not be used in clinical practice.

Some studies have stated that the penetration of resin-based sealers into dentinal tubules is higher than that of other sealers<sup>11,25</sup>. The degree of penetration of resin-based sealers depends on flow, surface tension, viscosity, chemical compounds, working time, setting time, and solubility of the sealers. AH26 is a highly hydrophilic epoxy resin and may set in humid environments<sup>26</sup>. Some studies have reported that the penetration depth of this sealer is acceptable<sup>27</sup>. The penetration of sealer molecules into dentinal tubules may reduce the bond strength of fiber posts. The present study showed no significant difference between the bond strength of AH26 and the control group, which is in accordance with the findings of Aleisa et al.<sup>17</sup>.

RealSeal SE, is a methacrylate resin-based self-adhesive sealer and contains acidic resin monomers that penetrate into the smear layer and bond to canal<sup>28</sup>. It seems that due to higher penetration of this sealer into dentinal tubules<sup>29</sup>, less bond strength was observed in comparison with the control group. However, this difference was not statistically significant. Despite the fact that this system is based on the theoretical engagement of the smear layer, recent studies have found that these sealers, especially self-etch sealers, cannot

establish a proper bond through the smear layer<sup>30</sup>. Consequently, it is recommended that EDTA be used prior to the application of sealer in root canals, to eliminate the smear layer, reduce microleakage and enhance sealing ability<sup>31</sup>.

The fiber post bond strength in the Guttaflow group was the lowest among the experimental groups. It appears that Paramineoil, a composite of Guttaflow, could contaminate root canal walls, reducing the bond strength of cemented posts<sup>32</sup>. Previous studies found that oils and lubricants have a significant impact on bond strength of self-etch systems, reducing over half the original bond strength, which is similar to the results of present study<sup>32-33</sup>. Aggarwal et al. found no significant difference between the fiber post bond strengths of the AH26 and Guttaflow groups compared with the control group. This may be caused by EDTA as a chelating agent prior to post cementation, which would clean any remaining sealer oil from root canal surfaces<sup>15</sup>.

Notwithstanding the fact that we tried to maximize accuracy of experiment and its comparability to *in vivo* environment, it is suggested to perform cyclic loading to better simulate oral cavity conditions.

It seems that according to their composition, sealers may have negative effects on the bond strength of fiber posts to root canal dentin. It must be highlighted that, because of negligible reductions in the push-out bond strength of samples, AH26 may be used as a safe sealer, with no concerns about negative effects on the bond strength of fiber posts. It is also suggested to consider future restorative treatment plan when selecting Guttaflow system while performing a root canal therapy.

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