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ORIGINAL ARTICLE

Effect of Different Root Canal Sealers on Push Out Bond Strength of Fiber Posts to Root Canal Dentin: An In- Vitro Study

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ABSTRACT:
Introduction: Fiber posts associated with resin cores are used in structurally compromised teeth to retain the final restoration. The residual root canal sealers left on dentin walls after post space preparation might affect the adhesion between the fiber posts and root dentin. The aim of this study was to evaluate the effects of calcium silicate sealer (Endosequence BC sealer), epoxy resin sealer (AH Plus) and zinc oxide eugenol based sealer (Tubliseal) on bond strength of fiber post to root dentin. **Methods**: Sixty extracted human maxillary incisors were decoronated and prepared using step back technique upto ISO #40. The samples were divided into 3 experimental groups and one control group depending upon the type of sealer used. In control group A, no sealer was used for the obturation. In groups B, C and D, the canals were filled with gutta-percha using Tubliseal, AH Plus and Endosequence BC sealers, respectively, by cold lateral compaction technique. After post space preparation, the fiber posts were cemented in the root canals using self-etch adhesive Rely X U200. Then 1-mm-thick disks were prepared from the coronal thirds of all the root canals and subjected to a push-out bond test using a universal testing machine. Mode of failure was determined using a stereomicroscope. Data were analyzed using the one-way ANOVA and post hoc Tukey's tests. **Results**: The control group demonstrated maximum bond strength and the Tubliseal showed least bond strength. The push-out bond strength values were similar for Endosequence BC sealer and AH Plus sealer ($P>0.05$). These values were significantly higher than that of the Tubliseal sealer ($P<0.05$). **Conclusion**: All the sealers tested decreased the bond strength of the fiber posts, with Tubliseal showing the greatest reduction in the bond strength
Key words: Root canal sealers, Glass fiber posts, Bond strength, Adhesive resin cement.

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INTRODUCTION

Structurally compromised endodontically treated teeth require the use of radicular posts associated with cores to retain the final restoration.[1] Glass fiber posts have been widely used because of their low rigidity, elastic compatibility with root dentin and their homogeneous complex formation with resin cement and root dentin.[2] These properties result in favorable stress distribution and reduced incidence of root fractures.[3] The type of the endodontic sealer used for root canal obturation can influence the retention of the post as it affects the bond between the resin cement and root dentin.[4] Zinc oxide eugenol based sealers have been widely used in endodontics. Tubliseal (Kerr Italia, Italy) is one of the commonly used eugenol based sealer available in two paste system. There is a substantial evidence supporting the negative effect of eugenol-containing sealers on the bond strength of fiber posts cemented with resin cements.[5,6] AH Plus (Dentsply DeTrey,Germany) is an epoxy resin sealer which has been widely used for obturation of root canals. It possesses many desirable properties like high opacity, low solubility and very slight shrinkage upon setting. Researchers have introduced it as a gold standard for the comparison of all the sealers and filling materials to be bonded in the root canal.[7] Recently, calcium silicate based sealers are introduced to achieve the biologic properties. Bioceramics are biocompatible, nontoxic, nonshrinking, and chemically stable within the biological environment. Another advantage of the material is its ability to form hydroxyapatite during setting process, thus forming a bond between dentin and filling material.[8]One of the popular bioceramic sealer is

Endosequence Bioceramic sealer (Brasseler, Savannah, GA, USA). The aim of this in vitro study was to evaluate the effect of three different root canal sealers on the bond strength of fiber posts cemented with a self-adhesive resin cement. The null hypothesis was that the type of root canal sealer had no effect on the dislodgment resistance of the fiber post.

MATERIALS AND METHODS

A total of 60 single-rooted maxillary incisors, extracted for periodontal reasons, were selected for our study. The teeth were cleaned of any soft tissue remnants and stored in 0.5% chloramine-T solution until use. Samples were decoronated to obtain a standardized root length of 14 mm. The working length was established by subtracting 1mm from the total root length. To simulate clinical condition, a closed environment was created by placing the samples inside the test tubes filled with polyvinyl siloxane material (Affinis, Coltene; Switzerland). A custom made jig was used for instrumentation procedure. All the root canals were prepared up to #40 as the master apical file by one operator and the coronal and middle thirds of the root canals were enlarged using #4, 3 and 2 GatesGlidden drills (Mani Inc., Japan). During the root canal preparation procedures, the irrigation protocol consisted of 3% NaOCl (Prevest Denpro, Jammu, India) irrigation during instrumentation and a final flush with normal saline at the end of preparation procedures, followed by a 3-min use of 17% ethylenediamine tetraacetic acid (Prevest Denpro, Jammu, India). After the final rinse with normal saline, the root canals were dried with paper points and were randomly assigned to 4 groups of 15 teeth each (n=15) and obturated with gutta-percha (Meta Biomed, Korea) using the cold lateral compaction technique. In group A (control) gutta-percha was used without sealer. In groups B, C and D, Tubliseal Zinc Oxide Eugenol sealer, AH Plus epoxy resin sealer and Endosequence Bioceramic sealer (Brasseler, Savannah, GA, USA) were used for root canal obturation, respectively. The sealers were used according to manufacturers' instructions. After obturation, Cavit G (3M ESPE, Seefeld, Germany) temporary restoration material was used for the sealing of the access cavity. The specimens were stored at 37ºC under 100% relative humidity for 7 days. After 7 days, Gutta-percha was removed from the root canals with #2 Peeso reamers (Mani Inc., Japan) to leave at least 4 mm of guttapercha at the apical third of the root canal. The post space was prepared up to a depth of 9 mm using the drill (1.2) of the post system (Rogin Dental, China). The post space was irrigated with distilled water and dried with paper points (Meta Biomed, Korea). The posts were tried in, cleaned with 70% alcohol for 5 sec and cemented in accordance with the manufacturer's instructions. RelyX U200 self-adhesive resin cement (3M ESPE, Germany) was placed onto a mixing pad and mixed for 20 seconds. The mixed cement was applied in and around the canal using an insulin syringe with a #40 needle. A thin layer of mixed cement was applied on the post and post was seated into the canal. Excess cement was removed while holding post in place and light-polymerized for 20 sec from an occlusal direction. After luting the posts, all samples were stored in water at 37ºC for one week.[9] Each root was horizontally sectioned into 1.0 mm thick slices using a diamond disc under continuous water cooling. Slices with filling voids and non-circular shape were excluded. The diameter of the coronal and apical end of intracanal filling material was determined with a digital caliper. Apical and coronal end of each specimen was marked with indelible marker. The selected samples were placed on top of metallic jig with base orifice to allow the filling material to fall through after failure of the bond. Two slices from each root corresponding to coronal and apical third were selected. The push out test was performed using a universal testing machine (HEICO, New Delhi, India) at a crosshead speed of 1mm/min. Each sample was loaded in apical to coronal direction to avoid any interference from root canal taper during the test. Plunger size that provided 75 to 80% coverage of intracanal material without touching the circumferential dentin and base orifice diameter of jig close in size, but slightly larger than diameter of intracanal material was selected for each specimen.The maximum force necessary to push the fiber out of the sample was considered as the bond failure point and was recorded by using the following formula:[10]

$A=2\pi r\times h$

where r is the radius of the root canal space and h is the thickness of the samples in mm.

Therefore, the bond strength (δ) was calculated in MPa using the following formula:

$\delta=F/A$

The push-out bond strength data were converted from Newtons to Megapascals (MPa).After push-out evaluation, the failure modes of all specimens were evaluated under a stereomicroscope (Kyowa Getner, Japan) at 40× magnification (**Figure 1**). The failure modes were classified according to the following criteria: Type I, adhesive failure between dentin and resin cement; type II, adhesive failure between resin cement and post; type III, cohesive failure within dentin; type IV, cohesive failure within cement; type V, cohesive failure within post; type VI, mixed failures. Two independent and calibrated operators analyzed each fractured specimen.

STATISTICAL ANALYSIS

One-way ANOVA was used to evaluate the effect of the sealer type on the bond strength of fiber posts and post hoc Tukey's tests were used for two-by-two comparisons of the groups. SPSS software (Statistical Package for Social Science, SPSS, version 18.0, SPSS, Chicago, IL, USA) was used for statistical analyses and the level of significance was set at 0.05.

RESULTS

The mean±standard deviation of bond strength values, in MPa, of the different groups are shown in**Table 1**. The maximum and minimum bond strength values were recorded in the control and Tubliseal groups, respectively. The sealer type had a significant effect on the bond strength (P=0.03). Fiber posts in Endosequence BC sealer group and AH Plus group had significantly higher bond strengths than that in the Tubliseal group (P=0.002), with no significant differences between the BC sealer and resin-based sealer (P=0.7).

The distribution of the failure modes is showed in **Table 2**. The most predominant failure pattern was Type I (between resin cement and dentin), followed by Type VI (mixed failures). Only few Type IV (adhesive failures between the cement and post), and Type V failures (cohesive fractures in cement and post, respectively) were observed. No Type III failures were observed.

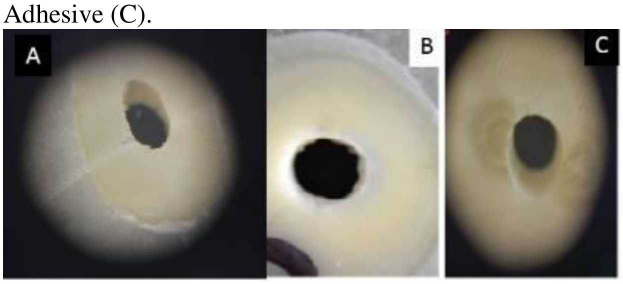
Table 1: The mean±SD of the push-out bond strength (Mpa) of study groups

Sealer type	Push out Bond strength
Group A (Control)	4.22±0.06
Group B (Tubliseal)	1.04±0.02
Group C (AH Plus)	2.22±0.02
Group D (Endosequence BC)	2.11±0.01

Table 2: Absolute distribution of the failure mode (in %) of the different experimental groups.

GROUPS	FAILURE MODES (PERCENT)					
	TYPE I	TYPE II	Type III	TYPE IV	TYPE V	TYPE VI
A (Control)	52	6	0	7	5	30
B (Tubliseal)	72	2	0	3	0	23
C (AH Plus)	67	3	0	6	2	22
D(Endosequence)	60	6	0	5	3	26

Figure 1: Modes of failure: Mixed (A), Cohesive (B), Adhesive (C).



DISCUSSION

Fiber posts form a uniform complex with the root canal walls after being cemented with resin cements. Their retention depends on the interface between root dentin, cement and post surface. Among the cements, resin based cements result in better retention, less microleakage and more resistance to tooth fracture.[11,12]The bond strength of post-cement-dentin interface is influenced by several factors. These include reaction of the luting agent with dentin, polymerization rate, polymerization shrinkage stress of the resin luting agent, the presence of endodontic sealer or gutta-percha remnants, and differences in the density and orientation of dentinal tubules in different areas of the root dentin.[13]In our study, the push-out bond strength test was used to evaluate the strength of the bonding between the fiber post to the root canal as this test provides a better estimation of the bonding strength than the conventional shear test because the fracture occurs parallel to the dentin-bonding interface.[14] Based on previous studies when the diameter of the plunger is 70-90% of that of the root canal, the effect of this confiding factor is minimal.[15]The results of the present study showed the highest bond strength values in the control group in which no sealer was used, which is in accordance with some other studies.[16]This might be due to the presence of patent orifices of dentinal tubules allowing the maximum penetration of resin cement.In the present study, the minimum bond strength was recorded in the Tubliseal group, a eugenol-based sealer. The similar results were obtained from some other comparative studies.[16-18]The reason might be attributed to the remnants of eugenol which increases the release of free radicals and interfer with the polymerization of resin cement.[19,20]Elimination of eugenol remnants in the root canal might be necessary to improve the adhesive process. AH Plus is a commonly used epoxy resin sealer used in association with gutta-percha. In the present study the bond strength of AH Plus, was higher than that of Tubliseal. A study reported that epoxy resin in the composition of resin-based cements, like AH Plus, did not interfere with the activation of free radicals in composite resin.[21]Therefore, the resin-based sealer has no negating effect on the adhesion of resin cement. The high bond strength of resin-based sealers is due to the presence of epoxy resin in their composition, which is similar to the composition of the resin cement. Recently, calcium silicate based sealers like Endosequence BC sealer has been introduced. This sealer has high sealing ability, proper bactericidal activity and biocompatibility. Little information is available on its adhesion properties. Based on our results, the bond strength of this sealer with the fiber post is similar to that of AH Plus. This might be due to the fact that the structure of this sealer did not compromise the adhesion of fiber post to the root dentin. Further studies are needed to study the long term effect of eugenol based sealers on dentinal bond strength and focus should be finding efficient modalities to remove the eugenol present within dentin after obturation with eugenol based root canal sealers.

CONCLUSION

Our null hypothesis was rejected. The type of root canal sealer affects the bond strength of fiber posts to root dentin. Zinc oxide eugenol based sealers have negative effect on the bond strength of post to dentin. Further studies are required to study the long term effect of root canal sealers on adhesive properties of fiber posts to root dentin.

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