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Effects of two different sealer materials on fiber post bond strength in root canal

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Abstract

Objective: The aimed of study to determine the effect of epoxy resin-based and MTA-based sealer on fiber post bond strength in the rootcanal wall.

Material and Methods: Samples were mandibular first premolar with a single root canal. They were divided into three groups: negative control group which is a gutta-percha obturation without sealer, gutta-percha obturation with epoxy resin-based sealer (AH Plus) and gutta-percha obturation with MTA-based sealer (MTA Fillapex) groups. Samples were decoronated, prepared, obturated and then stored in the incubator at room temperature for one week, the post space were prepared for fiber post insertion. The samples were mounted in the PVC pipes before insertion. The samples were stored in the incubator for one day before bond strength testing. Universal testing machine was used with the speed of 0.5 mm/minutes.

Results: The data were collected and analyzed using ANOVA. The result showed that the fiber post bond strength in the root canal obturated with epoxy resin-based sealer was higher (12.311 N/mm^2) than MTA-based sealer (10.786 N/mm^2) but that result was not statistically significant.

Conclusion: The root canal obturated with epoxy resin-based sealer does not yield a significant bond strength compared to MTA-based sealer.

Keywords: Sealer, Bond strength, Fiber post, Mineral trioxide aggregate, Epoxy resin

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Introduction

Long-term success of a restorative or prosthetic rehabilitation of teeth that had been treated by endodontic treatment depends on the restoration quality, clinical and health adaptation of supporting networks.[1] Post endodontic restoration on tooth that lost most of the crown structure generally requires intracanal post.[2–4] Intracanal post is used as retention for the final restoration on the crown structure of tooth treated by endodontic treatment.[2,5,6]

Recently, among clinicians, fiber posts are the mostly used post. It is a prefabricated type of post using new restorative concept because the post can mechanically bond with dentin structure when combined with an adhesive.[1] Fiber post is considered as a promising alternative because its elasticity modulus is similar to those of dentin and the resulting stress distribution is uneven and more aesthetic.[7–10]

Some researchers have reported that the factors affecting the fiber post bond strength is the shape and design of the post, the length and diameter of the post, the type of luting cement, cementation method and the type of sealer used in root canal obturation.[11] To support the bond of intracanal post, the cement is required to hold the post and the canal root wall.[2] One of the main causes of the restoration failure with intracanal post is the loss of attachment of fiber post. Therefore, cement types are one of the decisive factors for post crown restoration success.[5,12]

One of the cements often used until now is glass ionomer cement. The glass ionomer cement is quite hard and relatively high in compressive strength, but because it is fragile and has low resistance to fracture, it cannot be used to restore the tooth with a large load.[13] In addition other studies have shown that post bond is better when it is adhered with resin cement than with glass ionomer cement. It is reported that the luting cement containing resin became many clinicians choice because it is stronger, has better adhesion and its ease of use.[11]

Another factor affecting the bond, except cement, is the choice of sealer type during root canal obturation. One of the ideal characters of obturation material is the bond strength between sealer and dentin. This bond can minimize the risk of the release of obturation materials from root canal during restorative procedures or masticatory function, so that the clinical success of endodontic treatment can be achieved.[14] One of the factors that blocks attachment between the canal wall and resin cement is the rest of the root canal sealer. Until now, some countries are still using a sealer that contains

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zinc oxide eugenol. This Sealer can accumulate free radicals that interfered with polymerization reaction of resin cement, hence it can decrease the bond strength. It is mentioned that eugenol (2-Methoxy-4-allylphenol) can spread within the dentinal tubules and its phenolic components 2-Methoxy-4-allylphenol can disable molecules in the polymer chains which are formed and interfering with cement stiffening/setting and reduce the bond strength.[11,12,15]

Various kinds of root canal sealers are available in the market, but from some research, sealer that has epoxy resin as a basic component has some advantages that is good for apical covering, simple instrumentation and adhesive to dentin.[15]

Recently, salicylate-resin had been introduced as basis of sealer containing mineral trioxide aggregate (MTA). This material is biocompatible, radiopaque, mineralization stimulating and calcium ion releasing, has a high adhesivity to dentin and sealing ability which is similar to epoxy resin as basis of sealer. Some researches on this substance, such as antibacterial activity, cytotoxicity, solubility and bond strength to dentin root had been done, however, there are no studies that assessed the effect of salicylic resin as basis of sealer on the fiber posts bond strength of root dentin.[15] Therefore, the purpose of this study is to study the sealer influence that has epoxy resin and MTA as a basis on the fiber posts bond strength.

Material and Methods

Samples that are eligible on the inclusion criteria and corresponding estimates of large samples were taken and decoronation was done for approximately 2 mm of cementoenamel junction (CEJ) toward initial, but radiograph photos were taken beforehand. Root canal preparation was done by conventional techniques using the K-file (Dentsply Maillefer, Ballaigues, Switzerland) up to 50, at each turn the K-file was done by 5.25% NaOCl and saline irrigated using a syringe and needle.

After root canal preparation had been completed, it was dried with paper point and samples were divided into three groups where each group has nine teeth. The first group was obturated with sealer based MTA (MTA Fillapex, Angelus, Londrina, Brazil), the second group was applied a sealer based on epoxy resins (AH Plus, Dentsply Maillefer, Ballaigues, Switzerland) and the third group as a negative control was obturated without sealer. Root canal obturation used gutta-percha size 50, which was done by the lateral condensation technique which was previously done with reviewing the sealer in the root canal using Lentulo needle. Charging was inspected by radiographic density. After charging had been properly set and solidified, root canal was covered by Cavit-G. After that, all of the samples were stored in an incubator at room temperature for one week.

After one week, a root canal widening with peeso reamer from size 1 to 3 was done by using a low-speed handpiece until 10 mm of depth. Post space preparations were done with parallel drill up to 3 sizes (1:00, 1:25 and 1:50) by using a low-speed handpiece and then taking the radiographic picture.

Post insertion direction of the vertical axis was calibrated using a surveyor. Samples were implanted into the PVC pipe that contained a self-cured, but previously made retention prior to the tooth root with many small holes using a round bur and after it was stiff, it was cut and shaped with 1 x 1 cm size. After it was irrigated with NaOCl 5.25% and 0.9% saline, it was dried with paper points, then post fiber (Fibrekleer, Pentron) was held together using resin cement (Breeze, Pentron), approximately 0.5 cm for each sample into the root canal. The resin cement was previously applied into the root canal using a lentulo spiral about 0.5 cm in each sample. It was radiated for 40 seconds and then the samples were stored back in an incubator at room temperature for 24 hours.

The next stage was doing a test using Universal Testing Machine with 0.5 mm/min speed. Tests were completed with a tool that had been adjusted for this research.

Results

Based on examination of twenty-seven samples of the first premolars mandibular tooth that met the inclusion criteria, the MTA sealer bond strength was found to be the lowest compared to the other groups and the control group that actually had the highest bond strength between other groups. Table 1 shows, the MTA sealer bond strength only reached 10786 N/mm^2, while the bond strength of the control group reached 12988 N/mm^2. The other observation results showed that the bond strength of epoxy resin-based sealer reached 12311 N/mm^2. Table 1 also shows the normality test results which are useful to determine the statistical test used in next determination. All data were normally distributed so those could be used for parametric test, One-way Anova table 1 and figure 1

To find out how different the fiber post bond strength after obturation using second sealer, namely epoxy resin and MTA, can be seen in table 2. The table shows the difference of the fiber post bond strength between obturated with MTA sealer, epoxy resin and a negative control. Based on table 1, the MTA sealer bond strength is the weakest

Table 1 The distribution of fiber posts bond strength (N/mm²) by root canal sealers

Root canal sealer	n (%)	Bonding strength (N/mm 2) Mean ± SD	Normality test *p*–value
MTA sealer	9 (33.3%)	10.786 ± 4551	0.535 *
epoxy resin	9 (33.3%)	12.311 ± 6485	0.052 *
negative control	9 (33.3%)	12.988 ± 5303	0.978 *

* Normality test: Shapiro–Wilk test: *p*> 0.05: normal distribution data

Table 2 Differences in fiber post bond strength (N/mm²) of those that obturated with MTA-based sealer, epoxy resin and control

Root canal sealer	n (%)	Bonding strength (N / mm 2) Mean ± SD	*p*–value
MTA sealer	9 (33.3%)	10.786 ± 4551	
epoxy resin	9 (33.3%)	12.311 ± 6485	0.689 **
negative control	9 (33.3%)	12.988 ± 5303	

** One–way Anova test: *p*> 0.05: not significant

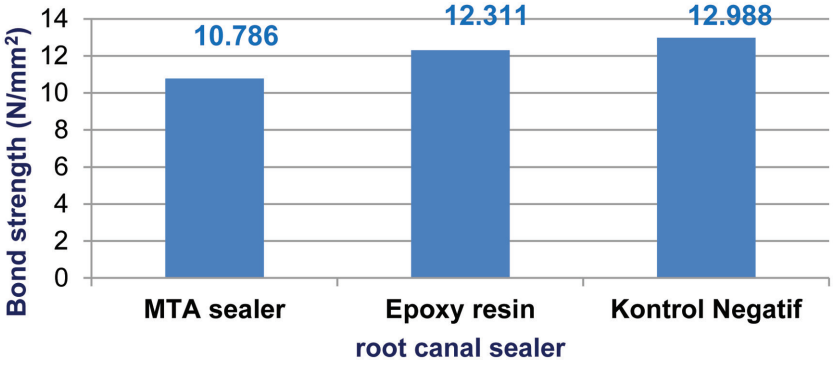

Figure 1 Distribution of fiber post bond strength (N/mm²) based on root canal sealers

bond strength than the other groups, which only reached 10786 N/mm². Instead, the bond strength of negative controls was the highest among the three groups with 12988 N/mm². Nevertheless, the statistical test results of One-way Anova demonstrated p:0689 (p>0.05), which means that there is no significant difference in the fiber post bond strength between those obturated with MTA sealer, epoxy resin, and control. One-way ANOVA test results showed no significant value, so that the post hoc test was not necessary.

Discussion

Post-endodontic restorations are a challenge for an endodontic specialist, particularly if there is loss-of-tooth structure that requires a lot of posts bonds, because this potentially leads to cause root fracture during application.[16] The right selection of post is expected to minimize that possibility. Fiber post that has tooth color has an elasticity modulus which is better than the metal post, so that the root fracture risk is smaller. In addition, fiber post is more easily removed so that the dental re-restoration can be done.[16]

There are several things that affect the post binding, including the used sealer for root canal obturation. Several previous studies have found that the sealer remaining of root canal affected the post bond strength on the root canal.[11]

The aim of this research is to determine the effect of epoxy resin-and MTA-based sealer against the fiber post bond strength on the root canal. In this study, post space preparation was done after root canal obturation. Some researchers had previously conducted in vitro studies on post binding, but previously the post space preparation and root canal cementation was not obturated. A previous study showed a decrease of post binding in the obturated dental compared to teeth without obturation. It is suggested that the rest of sealer in the root canal wall affects post binding. To make this study more clinically relevant, the post bond evaluation was conducted after root canal obturation.[16]

To eliminate the factor of tooth size differences, the tooth sample was the tooth with relatively equal in size. Besides that, the root canals were prepared using a large diameter drill with parallel forms. In this way, the post space had the same length and dimensions (1.5 mm and 10 mm).[11,17] Previous studies demonstrated that additional post-roughness surface with air abrasion will improve the post bond.[18,19] However, in this study the post surface is not roughened according to manufacturer's instructions.

Other factors which are also significant in the post bond are the luting cement selection[16] To hold the fiber posts in this research, luting resin cement was used because some earlier researches have shown better post bond when post are adhered with resin luting cement than that of conventional cement. This is caused by the resin luting cements that is capable of attaching firmly to the radicular and post dentin.[20–22] Chan et al.[23] also showed that the post cemented luting resin cement has higher bond strength than those that cemented with zinc phosphate or glass ionomer cement as conventional cement.[23]

Table 1 and figure 1 show that the percentage of distribution is based on the results on a tool of group 1 (MTA filllapex), group 2 (AH Plus) and group 3 (negative control). Based on the results, it shows that the negative group which was not using sealer has the highest bond strength compared to group I (MTA filllapex) and group II (AH Plus). This suggests that the rest of the sealer that affect fiber post bond strength is compatible with the

the high bond strength of fiber posts in the control group might be caused by an opened dentinal tubules orifices allowing maximum penetration of resin luting cement.[8,16] In table 2 it shows the difference between the bond strength of fiber posts obturated with MTA fillapex, AH Plus and control. The result shows that the average bond strength of fiber posts in the root canal wall obturated with MTA sealer group filllapex as the weakest compared to the other groups with an average of bond strength is 10786 N/mm^2. Group 2 obturated with AH Plus sealer has 12311 N/mm^2 average of bond strength and group 3 obturated without sealer has the greatest bonding strength that can reach 12988 N/mm^2.

The obtained results in this research show the bonding strength of fiber posts in the obturated dental with sealer based on epoxy resin is higher than MTA. This can be caused by the composition of the sealer. Sealer based on epoxy resin has greater resin content than the sealer based on MTA, so it can bind with the canal walls.[24,25] Luting resin cement used in this study was Breeze consisted of a mixture of hydrophilic components (i.e., BisGMA and HEMA) and hydrophobic monomers (i.e., TEGDMA). The later molecules will provide hydrophobic properties, required to control moisture condition of dentin and prevent absorption of excess water that would inhibit the polymerization reaction of material, accordingly it can bond well with the epoxy resin-based in the sealer.[26]

The bond between resin luting cement and fiber posts are formed by silane-treated barium borosilicate glasses contained in the resin luting cement (breeze) that bind with inorganic materials such as glass, filler minerals, metal and metal oxides from fiber posts creating a covalent bonding after polymerization.[26]

MTA-based sealer contains calcium ions that have the ability to adhere to the root canal wall. According to the research conducted by Camilleri et al.[27] it is suggested that if the sealer-based MTA makes contact with body fluids, it would stimulate calcium ions to be released that formed the deposition of calcium phosphate crystals and resulted in better apical sealing ability.[27] On the other hand, the composition of the resin content is only less capable to bind well with fiber posts.[24]

This is compatible with Reyes-Carmona et al.[28] who reported that the apatite formed by MTA and buffered phosphate saline can be deposited in the collagen fibrils, thus encourages mineral nucleation controlled in dentin, which is seen as the formation of a layer that has a structure similar to tags.[28] Sagsen et al.[29] in their study also concluded that the MTA filllapex has bond strength value which is being the lowest compared with root canal sealers containing epoxy and calcium silicate.[29]

The fiber post bond strength on the root canals obturated with AH Plus sealer is higher than those of obturated with MTA sealer filllapex, although in this study there was no significant difference. This may be due to the differences in the methods used such as time and dismissal tool gutta-percha, pulling method, as well as the other tools used. As in the bond strength research conducted by Aleisa et al .[11] they were using a different method to perform post preparations before doing obturation, dismissing guttap using the instrument such as warm plugger, and pulling method using U-shaped stainless steel rods.[11]

The formation of a thick smear layer on the post space affected the fiber post bond strength. This study used 5.25% NaOCl irrigation materials during root canal preparation and dual cure resin luting cement. Resin luting cement used as a luting material, also contained an ingredient that can demineralize smear layer though not entirely perfect, which may affect the study results.[14]

However, there are limitations of this research, which is difficult to certainly study the sealer residue on each side of the root canal that its excess affects the strength of the bond, because it only used two-dimensional radiographic results. This may give insignificant results so that in future studies, it can be considered using radiographic CBCT (Cone Beam Computed Tomography) to see the rest of sealer on each side of the root canal.

Conclusion

Based on the results of this research, it can be concluded that the bonding strength of fiber posts on the root canals obturated with sealer based on epoxy resin is higher than those of MTA, but statistically there is no significant difference. Therefore, further research is required to assess the bond strength by using different testing techniques and larger number of samples.

Conflict of Interest

The authors report no conflict of interest

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