

The effect of eugenol and resin based endodontic sealer on the bond strength of prefabricated fiber posts luted with two different resin cements

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Abstract

Aim: The aim of this study is to evaluate the effect of eugenol and resin based endodontic sealer on the bond strength of prefabricated fiber posts luted with two different resin cements.

Materials and methods: Sixty extracted single rooted incisors were included in the study. All selected teeth were decoronated. Selected teeth were prepared up to 50K

master apical file and step back reduction up to 90K file.

Post preparation was done using peeso reamers and Hi-rem fiber post drill.

Teeth were divided into four groups according to the type of root canal sealer used and type of luting cement used to cement the post:

In GROUP I & II, canals were obturated with CLC technique using eugenol based cement.

In GROUP III & IV, canals were obturated with CLC technique using resin based cement.

Group I (n=15): fiber posts luted with Resin cement with total etch adhesive system.

Group II (n=15): fiber posts luted with Self adhesive luting cement.

Group III (n=15): fiber posts luted with Resin cement with total etch adhesive system.

Group IV (n=15): fiber posts luted with Self adhesive luting cement.

Samples were stored at room temperature in 100% relative humidity for 24 hours before testing.

In a universal testing machine, post was gripped and a load was applied along the long axis of the post until dislodgement occurred.

Statistical analysis was performed using Tukey's Post Hoc test & one way ANOVA. Significance was set at $P < 0.05$

Results: Mean bond strength was highest for Group III (499.871 ± 13.161 SD) followed by Group IV (474.667 ± 10.744 SD), Group I (172.169 ± 16.209 SD) and Group II (89.267 ± 16.766 SD)

Conclusion: Resin based endodontic sealer showed higher bond strength of fiber posts when luted with resin cements as compared to Eugenol based endodontic sealer. Resin cements along with total etch technique was proved to be superior for cementation of fiber posts than self adhesive resin cements.

Keywords: AH Plus, Hirem posts, Rely X Ultimate, Rely X U 200, Tubliseal.

Introduction

The successful outcome of badly broken teeth with pulpal disease depends on endodontic treatment and on the post endodontic prosthetic reconstruction of the teeth.¹

Obturation in root canal treatment aims to seal periradicular tissues and eliminate all avenues of leakage

from the oral cavity or the per radicular tissues into the root canal system. Gutta percha along with sealer plays an important role in obtaining three dimensional seal of root canal system.²

Sealers have shown to influence the outcome of endodontic treatment as these are binding agents which adapt the gutta-percha to canal walls and fill up the voids, accessory canals and irregularities within the canal.³

Eugenol containing sealers, even though being the most commonly used root canal sealers, have certain shortcomings like inability to strengthen root as it does not adhere to dentin, prolonged setting time, shrinkage on setting, high solubility causing micro leakage, and ability to stain the tooth.⁴

To overcome these disadvantages, non-eugenol based sealers were introduced. Epoxy resin sealers provides adhesion to dentin and penetrates better into the micro-irregularities because of its creep capacity, which increases the mechanical interlocking between sealer and root dentin.⁵

The choice of sealer is not only dependent on its ability to create a sound seal or to be well tolerated by the periradicular tissues, but also on its ability to have no negative effect on procedures done after root canal treatment.

In cases with widely destructive dental tissue where retaining a core for a definitive restoration becomes difficult, intra radicular posts are used to provide retention to the core which replaces lost tooth structure and function.⁶

Retentive capacity of the post is of utmost importance, when considering endodontically treated teeth. **Standlee et al.** showed that post retention is increased with longer post as compared to shorter post, rough surface rather than smooth, parallel rather than conical posts. Certain other factors that influence the retentive capacity of posts are

type of luting agents used to cement it and the endodontic obturation sealer used.⁷

In 1990, fiber reinforced resinous matrix posts were introduced with the benefits of immediate cementation and single visit treatment. The modulus of elasticity of these posts are closer to that of dentin, which allows post to act as shock absorber, transmitting only fraction of stress to dentinal walls.⁸

Adhesive bond of fiber posts to the root canal dentine with a resin core buildup allows restoring root canal treated teeth, stabilizes the tooth substrate and also has an advantage of prosthetically restoring root canal treated teeth. Proper bond of the fiber post to the root canal wall is essential for the success of the treatment.

Various factors affecting the bond between adhesive cement and dentin are type of sealer used, thickness of resin cement, type of adhesive system used and morphology of dentinal surface.⁹

Overall retention of posts depends upon the bond strength between post-cement-dentin assemblies.¹⁰ Higher retentive values were found for resin based cements in comparison to Zinc phosphate and Glass ionomer cement.¹¹

Conventional resin cements bond to dentin using either total etch or self-etch adhesives. Total etch technique provides larger surface area for bonding, also promote a deeper hybrid layer and resin tag formation.¹²

Self-adhesive resin cements do not require pretreatment of the dentin. In the self-adhesive resin cement, the etching, priming, bonding, and resin cement are combined in one component, so there is only one application procedure.¹²

Luting cements used for the cementation of fiber posts might be adversely affected by the presence of sealers in the post spaces. Numerous studies have shown the inhibiting effect of eugenol on polymerization when resin based luting cements are used for post cementation.¹³

Resin based sealer is believed to provide better results because of its content of epoxy resin and absence of substances affecting polymerization which improves the strength of posts.¹⁴

Thus, purpose of this study is to evaluate the influence of eugenol and resin based sealer on the bond strength of prefabricated fiber posts luted with two different resin cements and to compare the bond strength of two different resin luting cements.

Materials and Methods

Sixty extracted, intact single rooted permanent incisors were collected for this study. Samples with completely formed apex having relatively straight roots were included whereas teeth with caries, cracks, previous restoration, curved roots, and calcified canals were excluded from this study.

Maintaining all the aseptic precautions, teeth were cleaned with an ultrasonic scaler to remove calculus, debris and soft tissue attachments. Selected teeth were sterilized according to occupational safety and health hazards norms (OSHA Norms) and stored in 10% formalin until further use.

Teeth were kept hydrated at room temperature in saline at all times during the study except during procedures and testing.

All selected teeth were decoronated 2mm coronal to most incisal point of cementoenamel junction using a low speed diamond disk under copious water cooling. Both the working length and the reference point of each individual canal were recorded. All canals were cleaned and shaped up to master apical file 50K. Step back reduction was done with every 1mm of working length with increase in file size up to size #90.

Gates Glidden drills #1, #2 and #3 were used for most coronal portion of the canals. Peeso reamers #1 and #2 were used in the canals to obtain 8-mm deep post spaces

corono-apically at 1500rpm. Hirem fiber post drills were used sequentially with #1 and #2. Final post space preparation was done with Hirem Fiber post drill #3 for placing Hirem prefabricated fiber post #3.

Canals were irrigated with 5% sodium hypochlorite. Final irrigation was performed by 17% ethylene diaminetetraacetic acid (EDTA) followed by saline.

All 60 samples were randomly divided into four groups.

Group -I, Group -II, Group -III and Group -IV according to the type of root canal sealer used and type of luting cement used to cement the post.

Group I: [n-15] Root canals obturated with lateral condensation technique using tubliseal (Eugenol based sealer) and posts luted with Rely X Ultimate luting cement (Resin cement with total etch adhesive system).

Group II: [n-15] Root canals obturated with lateral condensation technique using tubliseal and posts luted with RelyX U200 luting cement (Self adhesive cement).

Group III: [n-15] Root canals obturated with lateral condensation technique using AH Plus (Resin based sealer) and posts luted with Rely X Ultimate luting cement (Resin cement with total etch adhesive system).

Group IV: [n-15] Root canals obturated with lateral condensation technique using AH Plus and posts luted with RelyX U200 luting cement (Self adhesive cement).

Excess gutta-percha points were seared off at the orifice and condensed with plugger 3 mm below the canal orifice.

The coronal part of root canal was sealed with temporary filling material. All specimens were stored at room temperature for 24 hours to ensure setting of sealers.

Temporary filling material was removed and heated plugger was used to remove the gutta percha from the canals to a depth of 8 mm. Teeth were then embedded in self-cure polymethyl methacrylate resin to the level of the cemento-enamel junction.

In Group I and Group III the canals were etched with 37% phosphoric acid gel for 15 seconds and rinsed for 10 seconds. Following the application of adhesive, Rely X Ultimate luting cement were mixed according to the manufacturer's instructions. For Group II and Group IV Rely X U200 luting cement was mixed according to the manufacturer's instructions. Cement was applied to each post, and the post was seated in the post space with finger pressure.

Excess cement was removed. The posts remained passive in the canals while the cement polymerized. Additional light curing was performed for 20s with LED light directly over the post. Samples were stored at room temperature in 100% relative humidity for 24 hours before testing.

Each specimen was secured in a universal testing machine (TUF-C-1000 Servo Computerized machine, Pune). The post was gripped and a load was applied along the long axis of the post until dislodgement occurred. The load was applied at a rate of 0.5 mm/min. After failure of the bond between the post and the dentin, the load required for separation of the post was recorded for all the samples. The applied force was measured in Newton.

Statistical Analysis

All the values obtained from the study were tabulated and subjected to the statistical analysis using ANOVA test and Post- hoc Tukey's test using IBM SPSS-20 software, at the significance level of 0.05 ($P \leq 0.05 = \text{Significant}$).

Results

Mean bond strength was highest for Group III (499.871 ± 13.161 SD) followed by Group IV (474.667 ± 10.744 SD), Group I (172.169 ± 16.209 SD) and Group II (89.267 ± 16.766 SD) (Table 1).

To observe statistical analysis of data among all groups, One Way ANOVA test was applied and it was statistically significant ($p=0.05$). (Table 2)

Intergroup comparison of the bond strength values among the different groups was done with Tukey's Post Hoc test. There was statistically significant difference between the groups. ($P \leq 0.05$).

Table 1: The mean, standard deviation, standard error, minimum and maximum values of all groups

	Mean	Std. Deviation	Std. Error	Min.	Max.
Group I	172.169	16.209	4.185	150.78	197.47
Group II	89.267	16.766	4.329	70.11	121.11
Group III	499.871	13.161	3.398	480.96	526.37
Group IV	474.667	10.744	2.774	460.09	488.71
Total	308.993	182.956	23.619	70.11	526.37

Table 2: Comparison between all groups (ANOVA)

	Sum of Squares	df	Mean Square	F value	P value
Between	1963239.11	3.00	654413.04	3144.424	0.00
Within Groups	11654.64	56.00	208.12		
Total	1974893.75	59.00			

Discussion

The present study assessed the influence of different endodontic sealers on the adhesive properties of different resin cements used for cementation of fiber posts.

Resin cement are used to lute the posts, since they bond to radicular dentin as well as post allowing conservative post insertion techniques as well as reducing potential stress.¹⁵

One of the cementation methods used to condition root dentin for adhesion is the etch and rinse adhesive methods or total-etch technique.¹²

One of the leading causes of post failure is the loss of retention due to ineffective removal of root canal sealing materials prior to cementation of the post in the post space. The use of acid etchant is a tried and tested technique to eradicate the smear layer and facilitate the bonding process.¹⁶ The drawback of total etch technique involves variation in wetting or drying of dentin. To overcome the drawbacks of total etch adhesive and self-etch adhesives, self-adhesive resin cements were introduced. The etchant, primer, bonding agent and resin cement are combined in one component in self-adhesive resin cement.¹²

The lower bond strength of Group I and Group II compared to Group III and Group IV observed in the study is in agreement with the previous study conducted by Emmanuel C. Ngoh et al.¹⁷

Erik Keith Hansen et al. also stated the detrimental effects of eugenol on polymerization and proved that eugenol reduced the efficacy of bonding agents. Eugenol is known to interfere with collagen of dentin which affects the bonding.¹⁸

The lower bond strength of Group II when compared to Group I observed is in agreement with the previous study conducted by Y Theodor et al.¹²

Richard S. Schwartz et al. have stated that the use of 37% phosphoric acid into canals obturated with eugenol based sealer restored the retentive values of posts. The use of etchant in canals obturated with eugenol based sealer removed the residual eugenol.¹⁹

The lower bond strength of Group IV when compared to Group III observed in the present study is in agreement with the previous study conducted by Guido Migliau et al.²⁰ They concluded that total etch adhesive technique provides higher bond strength when compared to self-adhesive cements where no addition pretreatment is done.

Resin cement along with total etches procedure produces greater demineralization of dentin which resulted in deeper hybrid layer and resin tag formation than self-adhesive resin cement. Similar results were obtained in study of Parnian Alizadeh Oskoe et al.²¹

The lower bond strength in Group I when compared to Group IV can be attributed to the use of eugenol based sealer which affects the polymerization of resin cements used for cementation.

The higher values shown by Group III (Resin based sealer and RelyX Ultimate) in the present study can be attributed because of use of resin based sealer along with resin luting cement to lute fiber post forming a monobloc.

Eugenol molecules released from eugenol based sealers penetrate the dentinal tubules and interfere with resin based cements. Khalil Aleisa et al. have stated that the phenolic components present in eugenol based sealer are known to influence the polymerization of resin cements.²²

Eugenol, which is a radical scavenger, protonize the free radicals during polymerization process of resin cements affecting the degree of conversion which in turn reduces the bond strength of the material.²³

Whereas resin based sealers does not influence the polymerization of resin luting cements. Resin based sealers consist of epoxy resin bisphenol having affinity towards resin based luting cement resulting in better interaction compared to eugenol based sealers.²⁴

Cleaning and shaping/post space preparation leaves behind smear layer on the dentinal surface which blocks the tubules and inhibit the penetration of monomers. To achieve good dentin bonding, removal of smear layer and smear plugs is essential.¹⁹ Parvinder Singh Baweja et al. stated that acid etching removes the smear layer, opens the dentinal tubules, increases dentinal permeability and decalcifies the intertubular and peritubular dentin.²⁵

In total etch adhesive technique acid etching promotes intra-tubular resin-tag formation, resin infiltration into demineralized intertubular dentin, and surface adhesion all of which enhances the bond strength. Peritubular demineralization leads to cylindrical hybrid layer formation that anchorages the intertubular tags providing mechanical retention.²⁶

The lower values of self-adhesive resin cements in this study as compared to total etch adhesive technique can be attributed to the deficient hybrid layer on dentinal surface. Luca Giachetti et al. stated that self-adhesive resin cements have limited etching property as compared to etch and rinse and self-etch adhesives and also low degree of conversion which is responsible for lower bond strength values.²⁷

In this study, to evaluate the effect of sealers on the retention of cemented posts, the preparations for post spaces were accomplished before obturation.

In terms of bond strength, the values differ between samples depending on the conditions of the teeth and experimental design. Variation between studies includes difference in: preparation design, cementation procedures, sequence of post space preparation, surface treatment and dental materials used.

Conclusion

Within the limitations of this in vitro study following conclusions are drawn-

- 1) Eugenol based endodontic sealer (Tubliseal) significantly reduced the bond strength of fiber posts when luted with resin cements.
- 2) Resin based endodontic sealer (AH Plus) showed higher bond strength of fiber posts when luted with resin cements.
- 3) Resin cements along with total etch technique was proved to be superior for cementation of fiber posts than self-adhesive resin cements.

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