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In Vitro Evaluation of the Effect of Different Endodontic Sealers on Retentive Strength of Fiber Posts

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Clinical Relevance

Eugenol-based sealers significantly reduced the bond strength of prefabricated fiber posts luted with resin cement.

SUMMARY

Purpose: **There is limited information in the literature regarding the effect of different endodontic sealers on the bond strength of fiber posts luted with core buildup materials. The purpose of this study was to evaluate the effect of three different root canal sealers on the retentive strength of prefabricated fiber posts luted with a composite resin cement.**

Materials and Methods: **Fifty-four extracted single-rooted mandibular premolar teeth were prepared and randomly divided into three groups. The first two groups were obturated with gutta-percha and one of two eugenol-based root canal sealers (Endofil, Tubli-Seal). The third group (control) was obturated with gutta-percha and a resin-based root canal sealer (AH26). Prefabricated fiber posts were luted into the prepared post spaces with a composite resin cement (Multicore Flow). The pullout forces required for dislodgment of posts from their prepared post spaces were recorded. Data were collected and statistically analyzed.**

Results: **The AH26 group had significantly greater retentive strengths for the posts when compared with the Endofil and Tubli-Seal (eugenol-based sealers) groups ($p<0.0001$).**

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There was no significant difference between the means of the retentive strengths for the Endofil and Tubli-Seal groups (p=0.745).

Conclusion: **The chemical formulation of root canal sealers significantly affected the retentive strength for prefabricated fiber posts luted with a resin cement. Eugenol-based sealers significantly reduced the bond strength of prefabricated fiber posts luted with resin cement.**

INTRODUCTION

The use of posts in endodontically treated teeth may be required in order to aid in the retention of a core and final coronal restoration.[1] The retentive capacity of the post is critical for the long-term survival of the final restoration.[2] Retention of a post can be influenced by its shape and design,[3] its length and diameter, the type of luting agent used to cement it, the coronal tooth preparation after cementation, and the endodontic obturation sealer.[4-6]

With increasing demands for esthetic restorations, the use of tooth-colored endodontic posts have become more popular in recent years.[7] Tooth-colored posts, such as fiber-reinforced posts, have been advocated in retaining the core restoration because of their purported favorable physical properties and biocompatibility.[8]

The influence of dental cements on post retention has been investigated.[9,10] Fiber posts commonly are bonded into the root canals with the use of dual-polymerizing or self-polymerizing resin-based cements. Endodontic sealers are as influential as the luting medium in the loss of retention of the post.[11] Sealers based on epoxy resin are preferred because of their good physical properties and adequate biological performance.[11,12] Calcium hydroxide–based endodontic sealers may stimulate a biological closure of the apical region, thereby increasing treatment success.[13] Eugenol-containing sealers remain the most commonly used root canal sealer because of their long history of clinical success.[14] However, eugenol, like all phenols, has considerable radical scavenging properties, and this is thought to inhibit composite resin polymerization.[15-23] There is little agreement between studies on whether this interaction is clinically relevant,[15,16,18] and it is unclear if the presence of eugenol and other components of root canal sealers, remnants of pulp tissue, and/or a residual smear layer impair post retention.[24]

MultiCore® Flow (Ivoclar Vivadent, Schaan, Liechtenstein) is a dual-polymerizing, fluoride-containing composite resin designed for core buildup restorations of vital and nonvital teeth and luting of fiber posts. It appears from the literature review that there is limited information regarding the effect of eugenol-based sealers on the bond strength of endodontic posts luted with core buildup materials. This *in vitro* study was undertaken to evaluate the influence of two eugenol-based root canal sealers (Endofil or Tubli-Seal) and a resin-based root canal sealer (AH26) on the bond strengths of prefabricated fiber posts luted with Multicore® Flow. The null hypothesis was that the type of root canal sealer used had no negative effect on the retentive bond strength of cemented fiber posts.

MATERIALS AND METHODS

Fifty-four extracted single-rooted, human permanent mandibular first premolars of approximately the same size were selected for this study. Radiographs were taken to ensure the presence of a straight, single main root canal and completely formed apex in each tooth. The teeth were stored in a container in 0.5% chloramine T at 4°C and used within six weeks after extraction. Teeth were sectioned 1 mm coronal to the midfacial cementoenamel junction by using a low-speed diamond saw (Isomet 2000, Buehler Ltd, Lake Bluff, NY, USA) under copious water coolant.

The pulpal tissues were removed with a barbed broach of an appropriate size (Dentsply Maillefer, Ballaigues, Switzerland). Working length was established at 1 mm from the root apex. The canals were prepared with a rotary system (X-Smart, REF A 1004, Dentsply Maillefer) according to the manufacturer's instructions. Cleaning and shaping of the root canals were performed with Protaper Ni-Ti rotary instruments (sizes S1, S2, and S3, Dentsply Maillefer) following the crown-down technique. One milliliter of sodium hypochlorite (NaOCL; 5.25%) was reintroduced into each root canal after every instrument. After preparation, each root canal was irrigated with 2 mL of distilled water (pH 7), and the teeth were then randomly divided into three equal groups (n=18 in each group). The root canals were obturated with laterally condensed gutta-percha (Kerr/Sybron Corp, Romulus, MI, USA) and one of three different root canal sealers: AH26 (Dentsply DeTrey Gmbh, Konstanz, Germany), an epoxy resin sealer that is free of eugenol; Endofil (Promedica, Neumünster, Germany), a sealer containing eugenol; and Tubli-

Seal (Kerr Italia S.p.A., Salerno, Italy), a sealer containing eugenol. All obturated teeth were then stored in 100% relative humidity at 37°C for seven days.

Gutta-percha was removed, and post spaces were prepared using a no. 5 peeso reamer (Pulpdent Corporation, Watertown, MA, USA) at low speed to a depth of 8 mm. Radiographs confirmed that 5 mm of the gutta-percha root canal obturation always remained in each specimen. A no. 6 parallel-sided Parapost twist drill (Parapost Black P-42, Whaledent International, New York, NY, USA) was then used at low speed to prepare standardized post spaces (1.5 mm diameter and 8 mm long), and 2 mL of 5.25% NaOCL irrigation was performed in each post space. After preparation, each post space was irrigated with 2 mL of distilled water (pH 7).

Parallel-sided, size 6 prefabricated fiber posts (PF-1716, ParaPost Fiber Lux, Coltene/Whaledent, Altstatten, Switzerland) were used. The Parapost posts were checked for a passive fit in their respective canals before luting. To maintain moistness, teeth were held in a gauze sponge soaked in saline throughout all root canal therapy and post space preparations. Carbide burs were used to notch the roots. Specimens were then mounted with autopolymerizing resin (Ortho Resin, Dentsply DeTrey) in a short length of PVC pipe, and a dental surveyor (J.M. Ney Co, Bloomfield, CT, USA) was used to orientate the post space to the vertical axis of the tooth.

After canal irrigation with the 5.25% NaOCL and then irrigation with the distilled water (pH 7), the canals were dried with absorbent paper points. The posts were then luted with Multicore® Flow (Ivoclar Vivadent), a dual-polymerizing resin cement. Acid etching of the root canal walls was performed with 37% phosphoric acid (Ivoclar Vivadent) for 15 seconds, followed by thorough water rinsing and removal of excess surface moisture with paper points. AdheSE (Ivoclar Vivadent) bonding material was applied to the canal using a microbrush for 10 seconds, and excess adhesive was removed using paper points. Finally, the luting cement material was applied directly from the tip of syringe into the prepared post space in the root canal. Each fiber post was also coated with the luting cement without any surface pretreatment and then inserted into the canal using slight pressure. Excess cement was removed and then light polymerized for 40 seconds. The posts remained passive in the canals during the setting of the cement.

Table 1: *Means and Standard Deviations (SD) of Forces (Newtons) Required to Dislodge Posts (n=18)*[a]

Sealers	Mean±SD
AH26	271.5±78.4 A
Endofil	92.1±31.8 B
Tubli-Seal	105.6±45.3 B

[a] *Mean values designated with the same letter are not significantly different (p>0.05).*

The specimens were stored in 100% relative humidity at 37°C for 24 hours before testing. Each tooth specimen was vertically secured in the universal testing machine (Instron, Model 8500 Plus Dynamic Testing System, Instron Corp, High Wycombe, England). The force required to dislodge the post was determined using pneumatic grips that grasped the post head at its long axis. A constant loading rate of 0.5 mm/min was applied until cement failure was achieved. The peak force at the point of extrusion of the post segment from the test specimen was taken as the point of bond failure and was recorded in newtons (N).

Statistical Analyses

Statistical analyses of data were performed by using a statistical software package (SPSS v16.0, SPSS Corp, Chicago, IL, USA). A one-way analysis of variance (ANOVA) was applied to the mean retentive strengths of posts in canals with different sealers. A Tukey multiple comparison test was performed to determine which groups were significantly different. All statistical analyses were performed at a 0.05 level of significance (α=0.05).

RESULTS

The means and standard deviations (SD) of the results are summarized in Table 1. The highest mean force needed to dislodge the post was recorded for the posts obturated with gutta-percha and AH26 sealer (271.5 N), while the lowest force was recorded for the group of Endofil sealer (92.1 N). One-way ANOVA demonstrated that there were significant differences between the three root canal sealers (p >0.0001). The Tukey multiple comparison test revealed statistically significant differences between the AH 26 group and Endofil group as well as between the AH26 group and the Tubli-Seal group (p >0.0001 and p >0.0001, respectively). However,

there was no significant difference with the post retention between the Endofil and Tubli-Seal groups (p=0.745).

DISCUSSION

Several studies have shown that the cementation of fiber posts with an adhesive resin cement provides better retention, less microleakage, and a higher resistance to tooth fracture.[25,26] The present study assessed the influence of eugenol- and noneugenol-based root canal sealers on the retention of fiber posts cemented with MultiCore flow, a dual-polymerizing, filled, fluoride-containing composite resin designed for core buildup restorations of vital and nonvital teeth and luting of fiber posts.

All teeth were selected with relatively equal size and having the same canal configuration and a standardized post space was prepared for all canals. All post spaces were prepared with a relatively large ParaPost drill (1.5 mm in diameter), and all the posts were of the same size.

Retention of cemented fiber posts into prepared root canals relies on the interface resistance.[9,10,27] It has been reported that resin-based root canal sealers were more effective in sealing root canals than the zinc oxide–eugenol-based sealers.[11] AH26 is claimed not to shrink during setting and to adhere to dentin, ensuring a permanent seal.[11]

On the other hand, and despite their wide use, eugenol-based sealers (Endofil and Tubli-Seal) used for root canal obturation might cause a significant reduction in the adhesive effectiveness or modify the polymerized resin's surface,[19] resulting in decreased bond strength of the resin cement. In addition, the phenolic components are free radical collectors and delay the polymerization reaction when interacting with resin.[19] In the present investigation, the null hypothesis has been partially rejected since fiber posts cemented in canals filled with zinc oxide–eugenol-based sealers (Endofil and Tubli-Seal) presented the lowest tensile bond strength values, and no significant difference was found between the means of post bond strength for the Endofil and Tubli-Seal groups.

Although there is no consensus on the effect of eugenol on the polymerization of composite resin, some studies demonstrated that eugenol could inhibit the polymerization process.[6,19,20] In the current study, higher mean bond strength values were needed for vertical dislodgment of the fiber posts luted after the AH26 sealer had previously been used as part of the root canal obturation compared with those canals where Endofil and Tubli-Seal sealers had previously been used as part of the root canal obturation. In addition, Carvalho and others[21] observed that a temporary sealing cement containing eugenol reduced the bond strength of adhesive systems. On the other hand, Hagge and others[22] concluded that the chemical formulation of endodontic sealers did not affect significantly the retention of posts cemented with resin cements. Other authors have also reported that eugenol had no deleterious effect on resin cements.[5,23]

The intracanal removal of the residual eugenol might be necessary to improve the effectiveness of the adhesion process. A previous study[4] reported the negative effect of eugenol on the retention of posts cemented with Panavia cement; however, the irrigation of the canals with alcohol or acid conditioning restored the lost retention. This result was also verified by Schwartz and others[5], who reported no changes in the bond strength of posts luted with Panavia cement in canals filled with eugenol and previously treated with acid. On the other hand, Hagge and others[6] reported significant differences in groups treated with eugenol. Etching with 37% phosphoric acid has been found to be effective in restoring the retention that had been affected by eugenol.[28] The use of 37% phosphoric acid as the etching agent for most of the etch-and-rinse systems has been reported to eliminate the contaminated smear layer and results in demineralization of dentin to a depth of 9 to 10 μm. Studies have demonstrated that etch-and-rinse systems allow more effective bonding to the eugenol contaminated dentin surfaces, compared to the self-etch approach, due to the nonremoval of the sealer's debris entrapped within the smear layer. In the present study, there was no special canal treatment performed before post cementation, such as irrigation and disinfection with 70% ethanol, which might explain the reduced bond strength for the eugenol groups.

Tjan and Nemetz[4] investigated the effect of eugenol-containing endodontic sealer on the retention of prefabricated posts cemented with an adhesive resin technique and found that the presence of eugenol within the root canal resulted in significant loss of retention. However, they also found that residual eugenol in the root canal could be removed without any effect on retention of the post by irrigating the canal with ethyl alcohol (ethanol) or etching with 37% phosphoric acid; irrigation with

ethanol produced more consistent and reliable results. A substitute for ethanol irrigation is to use a 10-second phosphoric-acid irrigation to remove residual eugenol and rinse and dry the canal of excess moisture using paper points and a micro-aspirator tip within the canal.[4]

Push-out tests lead to a shear stress, which is comparable to the stress under clinical conditions at the interface between dentin and luting cement, as well as between the post and luting cement.[29] Considering the relative weakness of the post-root bond, Goracci and others[30] noticed that the push-out test was a more reliable technique in the determination of bond strengths between fiber posts and post space dentin due to the high number of premature failures occurring during specimen preparation and due to the large data distribution associated with microtensile testing. Nonuniform stress distribution is a disadvantage of the push-out test when it is performed on thick root sections.[31] To overcome this problem, original push-out test design was modified by slicing the posted root into 1-mm-thick specimens.[30] Therefore, this testing model was preferred for the present study to obtain two measurements for each third and to simplify calculations on the bonded area. The pullout test has been used by several studies to determine the values required to remove the post from the root canal.[4,31-33] It can be assumed that the posts that exhibit the higher retentive values would be less likely to loosen when subjected to stress. In the current study, although teeth were selected with similar size and canal shapes and received standardized post preparations, a wide range of strengths and relatively large standard deviations were obtained for some of the groups. However, comparison of the values reported in some earlier studies dealing with the retention of root canal posts that used extracted human teeth also revealed wide ranges in their measurements.[3,31,33] One possible explanation is that the size and shape of the root canals differ and/or the texture and properties of the inner surfaces of the root canals differ among the teeth used. This variability, however, also occurs in clinical situations. In addition, the diameter of the individual root canal preparation could affect how much of the canal was still covered with some eugenol-containing sealer. For example, if some AH26 remained in the canal around the post, then this would be more rigid than if some of either of the two eugenol-containing sealers were left filling that space.[33]

Within the limitations of this study, it was determined that the type of root canal sealer affected the retention of a fiber post cemented with resin cement. The findings should be considered by clinicians. Controlled prospective long-term clinical trials evaluating the use of fiber posts luted with resin cements after the use of various root canal sealers would provide information to help address this dilemma.

CONCLUSIONS

Within the limitations of this study, it was concluded that prefabricated fiber posts luted with multicore flow resin in canals previously obturated with gutta-percha and eugenol-based sealers (Endofil and Tubli-Seal) had significantly reduced bond strength compared to fiber posts luted with the same resin cement in canals previously obturated with gutta-percha and AH26 resin sealer.

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Conflict of Interest

The authors of this article certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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