

EFFECT OF RELINING ON FIBER POST RETENTION TO ROOT CANAL

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ABSTRACT

One of the clinically relevant problems dentists face when restoring endodontically treated teeth is the mismatch between fiber post and post space diameters, which results in an excessively thick resin cement layer. Fiber post relining appears as a solution for this problem. Objectives: The aim of this study was to evaluate the effect of fiber post relining with composite resin on push-out bond strength. Material and Methods: Twenty bovine incisors were selected to assess post retention. The crowns were removed below the cemento-enamel junction and the root canals were treated endodontically and flared with diamond burs. The roots were allocated into two groups (n=10): G1: fiber posts without relining and G2: fiber posts relined with composite resin. The posts were cemented with a dual-cured resin cement and the specimens were sectioned transversally. Three 1.5-mm thick slabs were obtained *per* root and identified as cervical, medium and apical thirds. The push-out test was performed at a crosshead speed of 0.5 mm/min until post dislodgement occurred. The failure mode of fractured specimens was analyzed under scanning electron microscopy. Data were analyzed by split-plot ANOVA and post-hoc Tukey's test at a pre-set alpha of 0.05. Results: Relined fiber posts presented higher retention values than non-relined post in all thirds. No statistically significant differences (p>0.05) were found among thirds for relined posts. All failures occurred at the interface between resin cement and root dentin. Conclusions: Relining with composite resin seems to be an effective method to improve the retention of fiber posts to flared root canals.

Key words: Post and core technique. Dental restoration. Endodontics.

INTRODUCTION

Intraradicular posts are commonly used to restore endodontically treated teeth when their remaining coronal tissue can no longer provide adequate support and retention for the restoration^{11,16}. For decades, endodontically treated teeth have been restored using cast metal posts. Despite the high retention and thin cement layer, these conventional posts present high elastic modulus and can lead to root fracture, according to several *in vitro* studies^{8,20}, though clinical evaluations have presented high success rates for cast metal posts^{1,8,17}. Another option to restore endodontically treated tooth is to use fiber posts. The fact that the fiber post, resin cement and dentin have similar elastic modulus has been considered as advantageous for improving the performance of restorations²⁵.

However, the mismatch between fiber post and post space diameters post remains a clinical challenge⁶. Although

the use of size-matched drills supplied by post manufacturers permits good fitting of posts to the canal walls, some canals have an elliptical shape in cross-section while posts have circular shape⁷. In addition, flared canals from carious extension, trauma, pulpal pathosis and iatrogenic misadventure also compromise the adaptation of fiber post to canal walls⁶. In these two cases, if the post does not fit well, especially at the coronal level, the resin cement layer would be excessively thick, and bubbles are likely to form in it, thus predisposing to de-bonding¹⁴.

One solution to overcome this problem is the use of dentin-bonded composite resin¹⁸. This technique increases the internal thickness of dentin of root wall and reduces the resin cement thickness. However, the light-activation of composite resin in more apical regions of the root canal is difficult and this may compromise this technique^{9,19,23}. Another solution is to reline the fiber post with composite resin¹⁵. This individual anatomic post increases the

adaptation of the post to root walls and reduces the resin cement thickness¹⁴. Therefore, the aim of this study was to evaluate the effect of post relining with composite resin on the push-out bond strength of fiber posts luted to flared root canals. The null hypothesis tested was that the individual anatomic post has no influence on the push-out bond strength.

MATERIAL AND METHODS

Twenty recently extracted bovine incisors with similar root sizes and lengths were selected for this study. The crowns were removed above the cemento-enamel junction with a low-speed diamond saw under water cooling in order to obtain a remaining root length of 14 mm. For the endodontic treatment, a step-back preparation technique was used. After determination of the working length using a size 15 K-file (Dentsply/Maillefer, Ballaigues, Switzerland), the canals were enlarged to a size 35 K-file (Dentsply/Maillefer) using a filling action prior to using Gates-Glidden drills (Dentsply/Maillefer). In order to flare the coronal and middle third of the canal a #2 Gates Glidden drill was inserted several millimeters into the canal, and then followed by sizes 3 and 4. Apical preparation was done with a size 40 K-file (Dentsply/Maillefer) as the final master apical file. The remaining of the canal was instrumented up to a size 70 K-file (Dentsply/Maillefer). All enlargement procedures were followed by irrigation with 2.5% sodium hypochlorite. The prepared root canals were obturated with gutta-percha cones using the lateral condensation technique and Sealer-26 resin sealer (Dentsply Indústria e Comércio Ltda., Petrópolis, RJ, Brazil). The filled roots were stored in relative humidity for at least 72 h to allow the resin sealer to set.

After the storage period, the coronal gutta-percha was removed with a heated Rhein instrument and 5-mm thick layer of gutta-percha was left for apical seal. In order to obtain a standardized flared canal, the root canals were enlarged with #4138 and #4137 high-speed diamond burs (KG Sorensen Indústria e Comércio Ltda., São Paulo, SP, Brazil) under water cooling. The depth of the post space preparation was 9 mm. The prepared root canals were allocated to one of the two experimental groups (n=10):

Non-relined fiber posts: The fiber post Fiberkor #2 (Penetron Corp., Wallingford, CT, USA) was treated with 37% phosphoric acid (3M Scotchbond etchant; 3M ESPE, St Paul, MN, USA) for 1 min, coated with a layer of the silane coupling agent (3M ESPE) and then Adper Single

Bond 2 adhesive system was applied and light-cured for 20 s.

Relined fiber posts: The fiber post Fiberkor #2 was treated in the same manner as described for the other group. After lubricating the canal walls with glycerin gel, the fiber post was covered with composite resin (Filtek Z-250; 3M ESPE) and inserted into the canal. The composite resin was light-cured for 20 s. The relined fiber post was removed and the composite resin was light-cured for additional 20 s. Copious rinsing was done to remove lubricant gel from the root canal.

In both groups, the canal walls were etched with 35% phosphoric acid for 15 s, water-rinsed for 15 s and gently air dried. Excess water was removed from the post space with absorbent paper points. Two coats of Adper Single Bond 2 adhesive system were consecutively applied to the root canal with microbrush tips (Microbrush Corp., Grafton, WI, USA). Adhesive excess was removed with an absorbent paper point, and the remaining material was gently air dried and light-cured for 40 s. Next, the dual-cured resin cement RelyX ARC (3M ESPE) was mixed and inserted into the root canal with #40 lentulo spiral (Dentsply/Maillefer). The posts were cemented into the root canal with light pressure, and excess luting material was removed. Light activation was performed through the cervical portion of the root for 40 s on the buccal and lingual surfaces, totalizing 80 s of light exposure. The resin cement and adhesive resin were light activated with a halogen light source (Optilux 501; Demetron Kerr, Orange, CA, USA) with output intensity of approximately 650 mW/cm² constantly measured during the experiment. The root/cemented post sets were stored in distilled water for 1 week at 37°C.

After the storage period, the specimens were sectioned transversally. Three 1.5-mm thick slabs were obtained *per* root and identified as cervical, medium and apical specimens. Each slab was positioned on the push-out jig, and load was applied at a crosshead speed of 0.5 mm/min until the post was dislodged. Data were analyzed statistically by split-plot ANOVA and post-hoc Tukey's test at a pre-set alpha of 0.05.

After debonding, the tested specimens were mounted on aluminum stubs, gold sputter-coated and observed by scanning electron microscopy (SEM) for failure mode determination. The failure mode was classified into four categories: adhesive between resin cement and fiber post; between the composite resin and resin cement; between resin cement and root dentin; or mixed.

TABLE 1- results of the push-out bond strength test in Mpa

Post Type	Root canal third			
	Cervical	Medium	Apical	
Non-relined post	6.24 (2.68)	4.27 (2.00)	4.46 (2.82)	B
Relined post	11.83(1.69)	11.81(3.86)	10.39(2.44)	A

Values are expressed as means (standard deviation). Different letters indicate statistically significant difference (p<0.05).

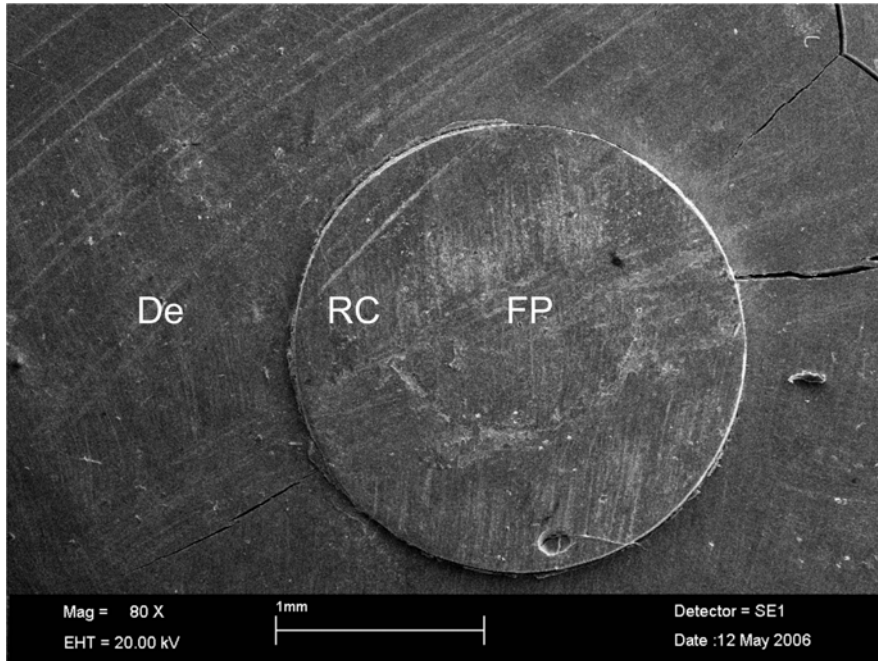


FIGURE 1- Non-relined fiber post specimen after the push-out test. Note that debonding occurred between the resin cement and the dentin. Dentin (De), Fiber-post (FP) and Resin cement (RC)

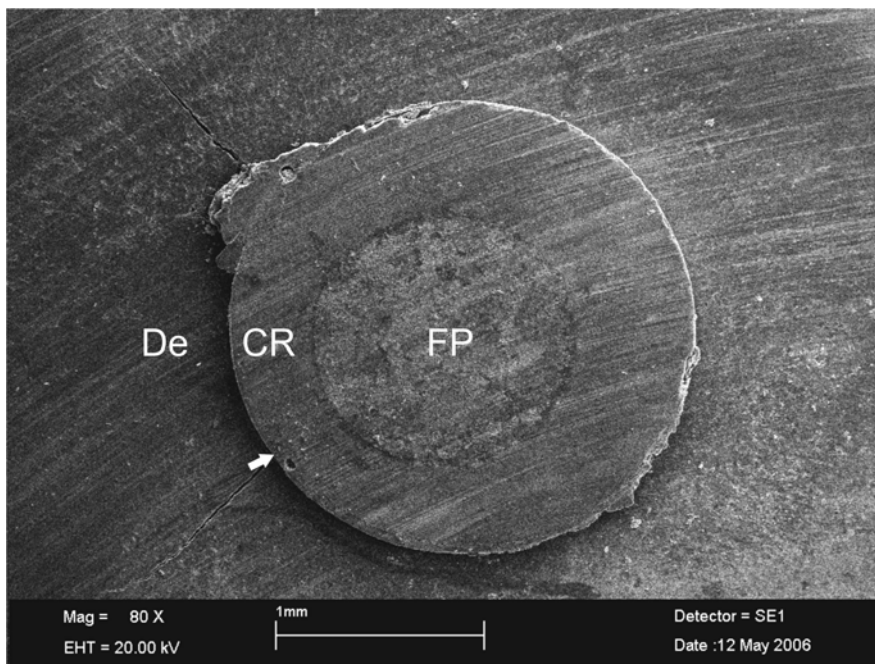


FIGURE 2- Relined fiber post specimen after the push-out test. Note that the failure also occurred in the interface between the resin cement and the dentin. Dentin (De), Fiber-post (FP), Composite resin (CR) and Cement resin (arrow)

RESULTS

Analysis of variance showed statistically significant difference for fiber post relining ($p < 0.0001$). However, the factor *depth* ($p = 0.169$) and the interaction between factors ($p = 0.475$) were not significant. The results are displayed in Table 1. The relined fiber posts presented higher retention than non-relined fiber posts in all root canal thirds. There

was no difference among thirds ($p > 0.05$), irrespective of the post type.

The SEM images showed that all failures occurred at the interface between the resin cement and root dentin. Figures 1 and 2 illustrate the failures for non-relined and relined fiber posts, respectively.

DISCUSSION

In the present study, fiber post relining improved fiber post retention at all evaluated root canal thirds. Thus, the null hypothesis was rejected. The main goal of fiber post relining is to reduce the thickness of the resin cement layer. Thin layers of cement present fewer bubbles and other defects than thick ones, and voids within the material may act as crack raisers and decrease post retention^{6,14}. Relining may reduce the possibility of cohesive failures. All failures in the present study occurred at the interface between the resin cement and root dentin, eliminating the effect of reducing defects and increasing the cement layer strength. Thus, the possible explanation for the improvement in retention with fiber post relining may be associated with the interaction between the adhesive and cement.

The adhesive system used in this study was the Adper Single Bond 2, which is material indicated by the manufacturer of RelyX ARC luting system. This is a two-step etch-and-rinse adhesive that presents hydrophilic and hydrophobic monomers in the same bottle and is incompatible with dual-cured resin cement used in the absence of light-activation^{21,28}. This incompatibility may occur because of the adverse chemical interaction between the unpolymerized acidic monomers of the adhesive and the basic tertiary amine in the cement²⁴. This interaction prevents the adequate polymerization of the resin cement and reduces the bond strength to the adhesive. However, the main factor contributing to the resistance to dislocation of the bonded fiber posts seems to be sliding friction¹². This occurs due to the complexity of adhesive procedure in the root canal because of both the difficulty of humidity control and adhesive light-activation²². In addition to the high C-factor (ratio between bonded and non-bonded surfaces) of the post hole, the bond strength of the adhesive system to root canal dentin is low²⁷. Since the friction occurs by contact, it is reasonable to assume that closer contact between resin cement and root dentin improves fiber post retention⁵.

The simplified adhesives, such as Adper Single Bond 2, behave as permeable membranes that allow the fluids to cross the adhesive layer after polymerization²⁹. The water may migrate to the composite-adhesive interface where it is trapped as water blisters, which might result in debonding at the resin-dentin interface. Despite the use of extracted and endodontically treated teeth, the intrinsic water that contributes to the stability of the collagen matrix in mineralized tissue cannot be completely removed, and water can remain mainly inside the dentin tubules³. Acid etching of the dentin surface with phosphoric acid removes the smear layer and the smear plugs, increasing tubule diameter and dentin permeability. Rinsing with water probably results in the retention of a substantial volume of water within the widened tubule entrances. As such water may not be completely removed by absorbent paper points; it may contribute to blister growth at the adhesive/resin cement interface. Considering the evidence that sliding friction is the main factor responsible for fiber post retention, these blisters may have reduced the contact between the resin

cements and root canal walls, resulting in low push-out bond strength¹⁰.

Blister growth is related to the availability of water and the polymerization rate of the resin cement, which in a slow polymerization reaction results in more water blisters²⁹. Thus, the effect of the adhesive permeability on the post retention is expected to be more accentuated in the more apical areas of the root canal where the light-activation of the resin cement is compromised. However, blister formation might also compromise the fiber post retention in the cervical third, where light-activation of the resin cement is effective. The adhesive resin flows in the apical direction and the solvent evaporation reduces the thickness of the adhesive layer. As the adhesive layer is thin, blisters can be formed due to rapid water movement across the adhesive, even when the resin cement is light activated²⁹. In addition, thin adhesive layers are not adequately polymerized due to the inhibition caused by oxygen³⁰.

Fiber post relining may reduce blister formation by increasing the pressure during cementation. Relined fiber posts present more intimate contact with the root canal walls than non-relined posts. Good adaptation of the post increases the pressure on the resin cement, which is transmitted to the cement-adhesive interface. Pressure application suppresses water sorption and blister formation, resulting in a better contact between the cement/post set and dentin⁴. This results in higher sliding frictional retention compared to when the fiber post is not relined, and consequently in higher push-out bond strength. Based on these results, it seems that relining increases fiber post retention by improving the contact between the cement and the adhesive, rather than by reducing the defects observed in the thin resin cement layers.

Several different mechanical testing methods have been used to measure the bond strength of fiber post to intraradicular dentin, to include: microtensile, pull-out and push-out tests. The push-out test provides a better estimation of the bond strength than the other tests because the fracture occurs parallel to the dentin-adhesive interface²⁶. In addition, the push-out test, such as pull-out, allows for evaluating the contribution of frictional resistance that is relevant to post retention to root canal¹³. The main drawback of the pull-out test is that it does not permit the comparison between the bonding to different depths of the root canal. In relation to microtensile test, the specimen preparation generates stress on the post-root interface, resulting in premature fails and compromising the results^{13,26}. It is important to emphasize that only the retention of the posts was evaluated in this study. Thus, further investigations, mainly clinical trials, are necessary to support the indication of fiber post relining procedure in the clinical practice.

CONCLUSIONS

Although the weakest link in post cementation is the interface between resin cement and root dentin, relining the fiber post with composite resin improved its retention at all

thirds of the root canal.

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