Application of Resin Adhesive on the Surface of a Silanized Glass Fiber–reinforced Post and Its Effect on the Retention to Root Dentin

Fernanda Weingartner Machado, DDS, Mayara Bossardi, DDS,[†] Tatiana dos Santos Ramos, BS, MSc,[†] Lisia Lorea Valente, DDS, MSc,* Eliseu Aldrighi Münchow, DDS, MSc,* and Evandro Piva, DDS, MSc*[†]*

Abstract

Introduction: In this study, the effect of different post surface treatments on the retention of glass fiber–reinforced post to root dentin was evaluated. The hypotheses tested were (1) post silanization would not improve its retention and (2) the application of silane plus resin adhesive on the post would enhance its retention. **Methods:** After root canal preparation, 4 different protocols ($n = 5$) of post surface treatment were evaluated, combined with or without silane (Silane coupling agent) and adhesive (Scotchbond Multipurpose): silane + adhesive (S/A), only silane, only adhesive, or no treatment (control). RelyX ARC was used for post cementation. Next, specimens were subjected to push-out bond strength testing, and data were analyzed by two-way analysis of variance and Tukey test ($P < .05$). **Results:** S/A showed higher bond strength than other protocols in the middle and coronal root regions ($P < .001$). Only silane did not enhance post retention compared with control ($P > .05$). The root dentin region influenced bond strength results only in the S/A group. **Conclusions:** Whereas silanization as the only post surface treatment did not improve retention, the combination of silane plus resin adhesive enhanced post retention to dentin in the middle and coronal root regions. *(J Endod 2015;41:106–110)*

Key Words

Push-out test, root canal, silanization, surface treatment

From the *Graduate Program in Dentistry, School of Dentistry, Federal University of Pelotas, Pelotas, Rio Grande do Sul, Brazil; and [†]Control and Developmental Center of Biomaterials (CDC-Bio), Federal University of Pelotas, Pelotas, Rio Grande do Sul, Brazil.

Address requests for reprints to Dr Eliseu Aldrighi Münchow, Graduate Program in Dentistry, School of Dentistry, Federal University of Pelotas, Pelotas, RS, Brazil 96015-560. E-mail address: eliseumunchow@gmail.com

0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2014.09.014

When endodontically treated teeth need extensive restoration, post systems are normally used to aid retention of the restorative material (1). Among the different types of posts available, glass fiber–reinforced (GFR) posts are the most common choice because they may be adhesively bonded to the root canal, contributing to the formation of a homogeneous root-cement-post system, which in this case is known as a tertiary monoblock (2). Nevertheless, because of their highly cross-linked epoxy resin-based structure, GFR posts need to be superficially treated (activated) to improve their chemical interaction with resin materials (eg, resin cements, resin composites).

Within the several pretreatment methods for surface activation of GFR posts, the application of silane (silanization) is by far the most frequent procedure used (3). Silanes are coupling agents that can interact with both organic (resin) and inorganic (glass) phases; however, they have little ability to react with epoxy resin-based posts (4) and also great possibility to undergo hydrolysis, weakening their coupling stability (5). Consequently, studies diverge about the real benefit of silanization in improving post retention (6–11); therefore, other substances have currently been investigated, such as resin adhesives (12), acid solutions (13–15), and hydrogen peroxide agents (16–18). Among these alternatives, the application of bleaching agents reached positive results (17, 18), although there is a lack of information about the negative effects on the post structure that may occur.

Irrespective of the surface pretreatment applied, failures of GFR posts frequently result in debonding or fracture, with the post-cement interface being the weakest link of the system (19). This may occur because of several factors such as the type of cement used (regular or self-adhesive) (3), inherent polymerization shrinkage of resin cements, and the high C factor of root canals (20, 21). In addition, the presence of remaining water may hamper the satisfactory interaction between post and cement (22). Moreover, resin cements have heterogeneous composition, which may poorly adhere to the silanized post surface because a highly hydrophobic surface is achieved (23). Thus, considering that hydrophobic resin adhesives have a more stable chemical composition (24), silanized GFR posts could be coated with an adhesive layer before application of the luting material, which in theory would enhance the interaction between post and cement and therefore enhance post retention to the root canal dentin.

Hence, the aim of this *in vitro* study was to evaluate the effect of applying silane plus adhesive as surface pretreatment of a GFR post on its retention to the root dentin. Two hypotheses were tested: (1) application of silane without a further resin adhesive layer would not improve post retention to root dentin, and (2) application of silane plus adhesive on the post surface would enhance its retention to root dentin.

Materials and Methods

Specimen Preparation

Twenty bovine incisors were obtained and cleaned in an aqueous solution of 0.5% chloramine-T for 1 week; next, they were kept in distilled water at –4°C until they were used (no longer than 2 months after extraction). The crowns were then removed at the cement-enamel junction with a water-cooled low-speed diamond saw (Isomet 1000; Buehler Ltd, Lake Bluff, IL) to obtain 15.0-mm-long roots. These were endodontically treated by the same operator by the crown-down instrumentation technique by using Gates Glidden (Union Broach, York, PA) #4 and #5 drills and 45–80 K-files in increasing order for instrumentation. Root canals were irrigated between each instrument by using 2.5% solution of sodium hypochlorite and 24% Trissodium EDTA (Biodinâmica, Ibiporã, PR, Brazil) as irrigants. Canal preparation was performed at a working length of 1.0 mm short of the apex. After final irrigation, root canals were completely dried with absorbent paper points and filled with Tanari (Tanari Indústrial, Manacapuru, AM, Brazil) gutta-percha and endodontic sealer (Sealer 26; Dentsply Maillefer, Ballaigues, Switzerland). The cervical openings of the root canals were then sealed with a eugenol-free provisional restorative material (Coltosol; Colténe, Altstätten, Switzerland), and the specimens were stored in 100% humidity in black film containers at 37°C for 7 days.

The post holes were prepared to depths of 11.0 mm from the cement-enamel junction by removing gutta-percha with Gates Glidden drills, leaving an apical seal of 4.0 mm. Each root was then instrumented with the drill matching the selected post (Exacto #3; Angelus, Londrina, PR, Brazil), flushed with distilled water, and dried with paper points.

Post Surface Pretreatment: Division of the Groups

Four different protocols ($n = 5$) of post surface pretreatment were evaluated in this study by applying silane (Silane coupling agent; Dentsply Ind e Com Ltda, Petrópolis, RJ, Brazil) and/or a hydrophobic unfilled resin adhesive (Scotchbond Multipurpose Plus Adhesive; 3M ESPE, St Paul, MN) (Table 1): group S/A: a single layer of silane plus a single layer of adhesive were separately applied on the post surface; each material was applied in accordance with the manufacturer's instructions (Table 1); group S: only a single layer of silane was applied on the post surface (positive control); group A: only a single layer of adhesive was applied on the post surface; and group C: no pretreatment (negative control).

Before division of the groups, all GFR posts were wiped with alcohol, in accordance with the manufacturer's recommendation.

Post Cementation

The post cementation procedure was equally performed for all groups. First, the adhesive system (Scotchbond Multipurpose Plus System) was applied according to the manufacturer's instructions for use (Table 1). The resin cement (RelyX ARC; 3M ESPE) was then manipulated and applied on the post surface with a disposable brush and also in the root canal by using a lentulo/paste carrier (Dentsply Maillefer) drill. The posts were inserted into the canal with slight pressure, and excess luting material was removed with a disposable brush. Once the post was luted, the cement was light-activated from the top of the post with a light-emitting diode light-curing unit for 60 seconds. Finally, the specimens were stored in 100% humidity in black film containers at 37°C for 7 days.

Push-out Bond Strength Test

Specimens were inserted into acrylic resin blocks with the tooth/post extruding from the block horizontally (25) and then transversely sectioned by using the aforementioned diamond saw, resulting in 1.0-mm-thick slices from the apical, middle, and coronal root regions (Fig. 1). Diameter and thickness measurements were obtained by using a stereomicroscope and digital micrometer (Mitutoyo, Santo Amaro, SP, Brazil) with 0.01-mm accuracy. All sections were likewise checked for potential artifacts caused by the cutting process; however, no artifacts were observed.

Subsequently, each slice was submitted to the push-out bond strength test (DL500; EMIC, São José dos Pinhais, PR, Brazil), with the load applied in the apical-coronal direction at a crosshead speed of 1 mm/min until the post was dislodged. The maximum load at failure was recorded in newtons (N) and converted into megapascals (MPa) by dividing the load applied by the bonded area (A), calculated by using the following formula:

$$A = \pi(r + R)*h^2 + (R - r)^2$$

where r and R are the smallest and the largest radius, respectively, of the cross-sectioned tapered post, and h is the thickness of the section (4).

TABLE 1. Materials Used in the Study

Material (manufacturer)	Lot number	Instructions for use
Silane Coupling Agent (Dentsply International)	416214	Mix the primer and activator solutions for 10–15 seconds. Wait 5 minutes. Apply the mixture over the post surface. Dry with a slight airstream. Repeat the mixture application and drying process.
Scotchbond Multipurpose Plus Adhesive (3M ESPE)	8RH	Apply the adhesive to the post and light-cure for 10 seconds.
Scotchbond Multipurpose Plus System (3M ESPE)	8RH	Etching: Apply Scotchbond etchant to the prepared tooth. Wait 15 seconds. Rinse for 15 seconds. Dry for 2 seconds. Use a paper point to remove any excess water in the canal. Activation: Apply Scotchbond Multipurpose plus activator to the canal by using paper point. Dry for 5 seconds. Priming: Apply Scotchbond Multipurpose plus primer to the canal by using a paper point. Dry for 5 seconds. Catalyst: Apply Scotchbond Multipurpose plus catalyst to the canal by using a paper point. Apply a coating of the catalyst to the post.
RelyX ARC (3M ESPE)	N336986	Dispense appropriate amount of cement onto a mixing pad and mix for 10 seconds.
Sealer 26 (Dentsply Maillefer)	688703E	Prepare the powder and resin components following the proportion of approximately 2–3 parts of powder to 1 part resin per volume. Manipulate the powder and resin until a smooth and consistent mix is obtained.