Influence of Chlorhexidine and Ethanol on the Bond Strength and Durability of the Adhesion of the Fiber Posts to Root Dentin Using a Total Etching Adhesive System

Doglas Cecchin, PhD, José Flávio Affonso de Almeida, PhD, Brenda P.F.A. Gomes, PhD, Alexandre Augusto Zaia, PhD, and Caio Cesar Randi Ferraz, PhD

Abstract

Introduction: The aim of this study was to investigate the effects of pretreatment of gel chlorhexidine (CHX) and ethanol (EtOH) on the bond strength and durability of the adhesion of the fiber post relined with resin composite to the root dentin using a total etch adhesive system. **Methods:** Forty bovine incisor roots were divided into four groups after phosphoric acid etching: irrigation with physiologic solution (control), 5 minutes with CHX, 1 minute with EtOH, and 5 minutes with chlorhexidine followed by 1 minute with EtOH. Fiber posts relined with resin composite were cemented with either RelyX ARC (3M ESPE, St Paul, MN) and a total etch adhesive system Scotchbond Multi-Purpose (3M ESPE). Each group was randomly divided into two subgroups: 24 hours of storage and 12 months of storage. All roots were sectioned transversely, and the push-out test was performed. Failure modes were observed, and the bond strength means were analyzed by analysis of variance and the Tukey test ($\alpha = 0.05$). **Results:** CHX irrigation resulted in homogeneous bond strength values at 24 hours and 12 months of storage ($P < .05$). A significant bond strength decrease was noticed after 12 months of storage when irrigations were performed with physiologic solution and EtOH application only or associated with CHX ($P < .05$). **Conclusions:** The use of CHX pretreatment could preserve the bond strength of the fiber post relined with resin composite to root dentin for 12 months. The use of EtOH and CHX followed by EtOH did not preserve the bond strength of the total etch adhesive system Scotchbond Multi-Purpose. *(J Endod 2011;37:1310–1315)*

Key Words

Bond strength, chlorhexidine, composite resin, ethanol, fiber post, root canal

Endodontically treated teeth are structurally different from nonrestored vital teeth, and they require specialized restorative treatment (1). The loss of dentin, including anatomic structures such as cusps and the arched roof of the pulp chamber, can result in tooth tissue fracture after the final restoration (2). In such cases, the use of intraradicular posts is recommended to promote the retention of the final restoration (3). However, because most clinical failures in teeth restored with fiber posts occur because of post debonding (4) in large root canals with thin tapered walls (5), the use of the fiber post relined with resin composite has been proposed, creating individualized intraradicular posts with a better adaptation to root canals (6).

Composite luting cements are used to bond the fiber posts to root canal dentin because they provide mechanical retention to dentin with a hybrid layer and mechanical and/or chemical bonding to the post (7, 8). Ideally, a post cement system will provide a tight seal impermeable to oral bacteria in case of coronal marginal leakage; however, this seal can be compromised by mechanical damage caused by occlusal forces or the degradation of the cement-dentin interface (9).

Current studies have indicated that the loss of integrity of resin-dentin bonds over time is likely the combined effect of hydrolytic deterioration of resinous components after water sorption (10) and the degradation of denuded collagen fibrils exposed to incompletely infiltrated hybrid layers (11, 12). The latter is attributed to an endogenous proteolytic mechanism involving the activity of matrix metalloproteinases (MMPs) (13) found in the coronal (14, 15) and radicular dentins (16).

Chlorhexidine digluconate (CHX) has been suggested as an irrigant in endodontic treatment (17, 18) because its antimicrobial activity (18) does not affect the bond strength of resin composite restorations to the coronal dentin (19) or the root canal sealer to dentin (20) or substantivity (21). According to Moreira et al (22), the CHX gel is an auxiliary chemical substance that does not interfere with collagen present in the organic matrix of root dentin; thus, it maintains the quality of the dentin substrate for posterior obturation or restoration of the tooth with resin-based materials. Furthermore, some studies have shown that CHX improves the longevity of composite adhesive bonding to dentin by inhibiting hybrid layer MMPs, which are collagen-degrading enzymes (23–27). Lindblad et al (28) and Leitine et al (29) showed that CHX did not negatively affect the immediate push-out bond strength in post-bond cementation. However, there is no evidence on adhesive durability when applied to lute posts to intraradicular dentin.

All contemporary adhesives, whether used in etch-and-rinse or self-etch adhesive systems, contain mixtures of hydrophilic monomethacrylates and more hydrophobic dimethacrylates to permit sufficient cross-linking to ensure that the adhesives are strong enough to serve as bonding agents (30, 31). Adhesives containing hydrophilic resins exhibit high water affinity, resulting in rapid deterioration of their mechanical

From Endodontics, Department of Restorative Dentistry, Piracicaba Dental School, State University of Campinas, Piracicaba, Brazil.
Address requests for reprints to Dr Doglas Cecchin, Avenida Limeira, 901, Piracicaba–SP, 13414-018, Brazil. E-mail address: dgscecchin@yahoo.com.br
0099-2399/$ - see front matter

doi:10.1016/j.joen.2011.05.004

properties (31). Because hydrophobic resins show a greater stability in aqueous environments, thereby improving the longevity of the adhesive interface compared with hydrophilic resins (32), it was recently proposed to replace residual water before the application of bonding agents with ethanol (EtOH) to coax hydrophobic monomers into the EtOH-saturated etched dentin (33–35).

Both adhesive and collagen degradation have been regarded as major causes of adhesive-dentin bond failures. The complete infiltration of hydrophobic resins facilitated by EtOH and the presence of MMP inhibitors within the hybrid layer would build the ideal interface (ie, resistant to hydrolysis and enzymatic activities). Therefore, the aim of this study was to investigate the effects of pretreatment by CHX and/or EtOH on the bond strength and adhesive durability of the fiber post relined with resin composite to root dentin using a total etching adhesive system. The hypothesis was that pretreatment with CHX and/or EtOH would prevent reductions of bond strength over time in root dentin.

Materials and Methods

Specimen Preparation

Forty freshly extracted bovine incisors with anatomically similar root segments and fully developed apices were selected. Teeth were stored in 0.02% thymol solution and prepared within 1 month of extraction. Each tooth was decoronated below the cementoenamel junction perpendicular to the longitudinal axis using a slow-speed, water-cooled diamond disc (Isomet 2000; Buehler Ltd., Lake Bluff, IL). The roots were cut to a uniform length of 14 mm from the apical end. The apexes of the teeth were sealed with a temporary filling material (Cavit W; Premier Dental Produtos, Rio de Janeiro, RJ, Brazil).

All root canals were prepared by one trained operator. Pulp tissue and predentine were removed, and the root canals were enlarged using #6 Largo burs (Maillefer, Ballaigues, VD, Switzerland) and a #130 file (Maillefer). The apical end (1 mm) was left unprepared to prevent the apical extrusion of solutions and luting cement. Roots were rinsed with 5 mL physiologic saline solution (NaCl) to remove the remaining debris. After 37% phosphoric acid etching (Cond AC 37; FGM, Joinville, SC, Brazil), 5 mL of sodium chloride (NaCl) was used to rinse, and the roots were divided into four groups (n = 10): group 1, no treatment (control); group 2, the root canals completely filled with 2% CHX in a gel base for 5 minutes followed by 5 mL of NaCl; group 3, roots were completely filled with 100% EtOH for 1 minute; and group 4, the root canals were completely filled with 2% CHX in a gel base for 5 minutes followed by 5 mL of NaCl and completely filled with 100% EtOH for 1 minute. All roots were dried with paper points and fiberglass posts relined with resin composite were cemented as described later.

Intracanal Restoration with Composite Resin

A total-etching adhesive system, Adper Scotchbond Multi-Purpose (3M ESPE, St Paul, MN), was applied to the root dentin according to manufacturer's instructions and light cured for 40 seconds using a halogen light-curing unit operated at 600 mW/cm^2 (Optilux; Demetron Res Corp, Danbury CT).

The intracanal restoration of the fiber post relining with resin composite was made with a fiberglass post (Angelus, Londrina, PR, Brazil) and composite resin (B0.5, Z250, 3M ESPE). The canal walls were lubricated with a hydrosoluble gel (Natrosol; Drogal Pharmacy, Piracicaba, SP, Brazil). The fiber post was covered with resin composite Z250 (3M ESPE) and inserted into the canal. After the removal of the excess resin, the tip of the light-curing unit was placed over the post, and the device was activated for 20 seconds. After composite resin polymerization, the post was clamped with needle-nose pliers and removed from the canal. The completion of the polymerization of the fiber post relining with resin composite was performed outside the root canal for 40 seconds.

After copious rinsing removed the lubricant gel from the root canal, the root canals of all groups were dried with absorbent paper points. One drop of the bond of the Adper Scotchbond Multi-Purpose system was applied onto the root canal surface, and the excess was removed with absorbent paper points and light polymerized for 40 seconds. The dual-polymerizing resin luting material Rely X ARC (3M ESPE) was mixed and injected into the prepared root canal with an appropriate Centrix syringe (20 G) (DFL, Rio de Janeiro, RJ, Brazil). Subsequently, the fiber post relined with resin composite was covered with cement and seated inside the root canal and kept under finger pressure for 20 seconds; the excess cement was then removed. The cement was light polymerized for 30 seconds on each surface (ie, buccal, palatal, mesial, and distal), resulting in a 2-minute light polymerization cycle. Specimens of each group were randomly divided into two subgroups (n = 5) according to their storage: 24 hours of water storage and 12 months of water storage.

Push-out Test: Specimen Preparation, Post Dislodgment, and Failure Pattern Analysis

Each root was cut horizontally with a slow-speed, water-cooled diamond saw (Isomet 2000, Buehler Ltd) to produce two slices approximately 1 mm thick for each root region (ie, apical, middle, and coronal). Seven slices were obtained from each root canal. The first slice was excluded. Thus, the six slices were considered from each root canal (n = 30).

The push-out test was performed by applying a load at 0.5 mm/min in the apex in the direction of the crown until the fiber post relined segment was dislodged from the root slide. Care was also taken to ensure that the contact between the punch tip and post section occurred over the most extended possible area to avoid any notching effect of the punch tip into the post surface.

To express the bond strength in megapascals (MPa), the load at failure recorded in newtons (N) was divided by the area (mm^2) of the post-dentin interface. To calculate the bonding area, we used the formula π (R + r) $[(h^2 + (R\text{-}r)^2]^{0,5}$, where R represents the coronal root canal radius, r the apical root canal radius, and h the thickness of the slice. The thickness of each slice was measured using a digital caliper (Vonder, Curitiba, PR, Brazil), and the total bonding area for each root canal segment was measured under 20× magnification with a stereoscope (Lambda Let 2; ATTO Instruments Co, Hong Kong, China) and ImageLab 2.3 software (University of São Paulo, São Paulo, SP, Brazil).

The fractured specimens were sputter coated with gold in a Denton Vacuum Desk II Sputtering device (Denton Vacuum, Cherry Hill, NJ). Thus, the fractured specimens were observed by scanning electron microscopy (JSM-5600LV; JEOL Ltd, Tokyo, Japan) at 40× magnification to classify the failure pattern into five types (36): (1) adhesive between the post and resin cement (no cement visible around the post); (2) mixed, with resin cement covering 0% to 50% of the post diameter; (3) mixed, with resin cement covering 50% to 100% of the post surface; (4) adhesive between resin cement and root canal (post enveloped by resin cement); and (5) cohesive in dentin. The means and standard deviations of bond strength were calculated, and the data were analyzed using analysis of variance and the Tukey test for post hoc comparisons (α = 0.05).

Results

The means and standard deviations are presented in Table 1. The statistical analysis of the data revealed significant differences among the