Influence of Chlorhexidine Application Time on the Bond Strength between Fiber Posts and Dentin

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Abstract

Introduction: The aim of this study was to investigate the effects of chlorhexidine (CHX) application time on the bond strength and durability of the adhesion of fiber posts relined with resin composite to the root dentin. **Methods:** Eighty bovine incisor roots were divided into 4 groups after root preparation: control group (irrigation with physiological solution) and experimental groups, CHX for 30 seconds, CHX for 60 seconds, and CHX for 120 seconds. Fiber posts relined with resin composite were cemented with RelyX ARC. The Scotchbond Multi-Purpose total-etching adhesive system was used in half of the samples of each group, and the Clearfil SE Bond self-etching adhesive system was used in the other half. The samples were randomly divided into 2 subgroups, 24 hours of storage and 12 months of storage. All roots were sectioned transversely, and push-out tests were performed. Bond strength means were analyzed by analysis of variance and Tukey test ($\alpha = 0.05$). Failure mode was determined by examining specimen's surfaces under scanning electron microscope, and its distribution was evaluated by using χ^2 test ($\alpha = 0.05$). **Results:** CHX pretreatment resulted in homogeneous bond strength values at 24 hours and 12 months of storage, irrespective of the CHX application time and adhesive system ($P < .05$). A significant bond strength decrease was noticed after 12 months of storage when irrigation was performed with physiological solution in the control groups ($P > .05$). Significant differences were observed for fracture patterns ($P < .001$). **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, irrespective of the CHX application time and adhesive system used. *(J Endod 2014;40:2045–2048)*

Key Words

Application time, bond strength, chlorhexidine, durability, fiber post, root canal

Fiber-reinforced posts have been widely used for the restoration of endodontically treated teeth. Because of the similarity in elastic behavior between fiber posts and the residual root dentin, root fracture rarely occurs in these restorations (1). To improve the retention of the composite core to post and tooth, prefabricated fiber posts are cemented with adhesives and composite resin luting cements (2, 3). However, adhesion between resin and dentin is considered to be a weak point in luting a fiber post (4).

Current studies have indicated that the loss of integrity of resin-dentin bonds over time is likely to be due to the degradation of denuded collagen fibrils exposed to incompletely infiltrated hybrid layers (5, 6). This is attributed to an endogenous proteolytic mechanism involving the activity of matrix metalloproteinases (MMPs) (7) found in the coronal (8–10) and radicular dentin (11, 12). Furthermore, recent studies revealed that cysteine cathepsins are also present in dentin, which may also contribute to the breakdown of the exposed collagen in dentin hybrid layers and caries progression (13, 14).

Chlorhexidine digluconate (CHX) has been proposed as an irrigant in endodontic treatment because of its antimicrobial activity (15), substantivity (16), and also because it does not affect the bond strength of resin composite restorations (17) and root canal sealers to the dentin (18). According to Moreira et al (19), CHX does not promote morphologic structure alterations in the dentin organic matrix of root dentin; thus, it maintains the quality of the dentin substrate for later obturation or restoration of the tooth with resin-based materials. Moreover, some studies have shown that CHX has beneficial effects on the preservation of resin-dentin bonds by inhibiting the proteolytic activity of MMPs in the hybrid layer (2, 3, 20–22) and that CHX can also inhibit the activity of dentin cysteine cathepsins (23).

Both *in vitro* and *in vivo* studies have shown that CHX applied to demineralized dentin postpones the resin-dentin degradation of adhesive interfaces, when compared with interfaces to which no CHX is applied (2, 3, 20–22). Despite these advantages, the use of CHX demands more chair time during the adhesive procedure, and this contrasts with the clinician's needs for simplification. Therefore, the aim of this study was to investigate the effects of CHX application time on the bond strength and durability of the adhesion of the fiber post relined with resin composite to the root dentin by using a total-etching and a self-etching adhesive system. The tested null hypothesis was that irrespective of the application time, CHX could not prevent the bond strength reduction of fiber posts to root dentin after 12 months of water storage.

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Materials and Methods

Specimen Preparation

Eighty freshly extracted bovine incisors with anatomically similar root segments and fully developed apices were selected. Each tooth was decoronated below the cementoenamel junction perpendicular to the longitudinal axis. The roots were cut to a uniform length of 14 mm from the apical end. The apices of the teeth were sealed with a temporary filling material (Cavit W; Premier Dental Produtos, Rio de Janeiro, RJ, Brazil).

Pulp tissue and the predentin were removed, and the root canals were enlarged by using #6 Largo burs (Maillefer, Ballaigues, 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 physiological saline solution (NaCl) to remove remaining debris, and the roots were divided as follows: control group, no treatment; and experimental groups: the root canals were completely filled with 2% CHX for 30 seconds, 60 seconds, or 120 seconds. All roots were dried with paper points, and fiberglass posts relined with resin composite were cemented as described below. The Scotchbond Multi-Purpose (SBMP) total-etching adhesive system was used in half of the samples of each group, and the Clearfil SE Bond (CB) self-etching adhesive system was used in the other half.

Intracanal Restoration with Composite Resin

The intracanal restoration was done by using fiberglass posts no. 3 (Angelus, Londrina, PR, Brazil) relined with composite resin (B 0.5, Z250; 3M ESPE, St Paul, MN). Initially, the adhesive systems were applied into the canals according to manufacturer's instructions. CHX was applied after 37% phosphoric acid etching and before primer application when SBMP was used. In the case of CB, CHX was applied before primer application. Both adhesive systems were light-cured for 40 seconds by using a halogen light-curing unit operated at 600 mW/cm^2 (Optilux; Demetron Res Corp, Danbury, CT). Then, the walls were lubricated with a water-soluble gel (Natrosol; Drogal Pharmacy, Piracicaba, SP, Brazil). The posts were cleaned with 37% phosphoric acid for 5 seconds, washed, and dried with an air/water syringe. Next, they were silanized twice, waiting 60 seconds after each application. SBMP or CB adhesives were applied to the post surface and immediately polymerized for 20 seconds on each side. The fiber post was covered with resin composite and inserted into the canal, and resin was polymerized for 20 seconds. After removing the post, polymerization was completed outside the root canal for more than 40 seconds (2, 3, 23).

After copious rinsing to remove the lubricant gel from the root canal, the root canals were dried with absorbent paper points. One additional drop of the respective adhesive system was applied onto the root canal surface, and the excess was removed with absorbent paper points before light polymerization for 40 seconds.

The dual-polymerizing resin luting material Rely X ARC (3M ESPE) was mixed and injected into the prepared root canal with a Centrix syringe (Shelton, CT) by using an appropriate needle (20-gauge). 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, with the excess cement removed. The cement was light-polymerized for 30 seconds on each surface (buccal, palatal, mesial, and distal), resulting in a 2-minute light polymerization cycle. Specimens of each group were randomly divided into 2 subgroups according to their storage, 24 hours of water storage and 12 months storage in water, which was renewed every 15 days.

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, Lake Bluff, IL) to produce 2 slices approximately 1 mm thick. Seven slices were obtained from each root canal. The first slice was excluded. Thus, 6 slices were considered from each root canal (n = 30).

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

The bonding area was calculated as previously described (2, 3), and the bond strength values were expressed in megapascals (MPa). The fractured specimens were sputter-coated with gold in a Denton Vacuum Desk II Sputtering device (Denton Vacuum, Cherry Hill, NJ) and observed by scanning electron microscopy (JSM–5600LV; JEOL Ltd, Tokyo, Japan) to classify the failure pattern into 5 types (2, 3): (1) adhesive between the fiber post and resin cement (no cement visible around the post); (2) mixed, with resin cement covering 0%–50% of the post's diameter; (3) mixed, with resin cement covering 50%–100% of the post's surface; (4) adhesive between resin cement and root canal (post enveloped by resin cement); and (5) cohesive in dentin.

Bond strength data were analyzed by using analysis of variance and Tukey test for post hoc comparisons ($\alpha = 0.05$). The distribution of failure patterns was evaluated by χ^2 test ($\alpha = 0.05$).

Results

The means and standard deviations are presented in Table 1. The statistical analysis revealed significant differences among the groups ($P < .05$). Immediate groups showed similar bond strength values with or without CHX pretreatment ($P > .05$). After 12 months of storage, a significant decrease in the control group was observed ($P < .05$), whereas the use of CHX preserved the bond strength in the groups stored in water for 12 months ($P < .05$), irrespective of the CHX application time and adhesive system.

A significant difference in predominant failure mode between groups was revealed by the χ^2 test ($P < .001$). The mixed failure types 2, 3, and 4 were the predominant failures in all groups (Fig. 1). When

TABLE 1. Bond Strength Means (MPa) and the Respective Standard Deviations Obtained in Each Experimental Condition

	SBMP		CB	
Groups	Immediate	12 mo of storage	Immediate	12 mo of storage
NaCl (control)	5.92 ± 1.79^{aA}	4.38 ± 1.34^{bB}	6.38 ± 0.98^{aA}	4.15 ± 1.15^{bB}
CHX for 30 s	5.89 ± 1.37^{aA}	5.76 ± 1.31^{aA}	5.66 ± 0.47^{aA}	5.41 ± 1.16^{aA}
CHX for 60 s	6.39 ± 1.44^{aA}	6.02 ± 1.38^{aA}	6.00 ± 1.41^{aA}	5.80 ± 1.53^{aA}
CHX for 120 s	6.29 ± 1.42^{aA}	6.06 ± 1.55^{aA}	6.01 ± 1.54^{aA}	5.81 ± 1.09^{aA}

Comparisons are only valid within each adhesive system. Means followed by different uppercase letters in same row and lowercase letters in same column are significantly different at 5% level.