Influence of Using Clinical Microscope as Auxiliary to Perform Mechanical Cleaning of Post Space: A Bond Strength Analysis

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Abstract

Introduction: The aim of the present study was to evaluate the influence of using a clinical microscope while performing mechanical cleaning of post space walls on the bond strength of a fiberglass post to dentin. **Methods:** Forty-five bovine roots were used. After preparation, roots were filled using gutta-percha and Pulp Canal Sealer (SybronEndo, Orange, CA). Subsequently, for post space preparation, the roots were divided into 3 groups: control (only heat condenser + specific bur of the post system); cleaning without a microscope, mechanical cleaning (after the procedure described in the control group, round burs were used to improve cleaning); and cleaning with a microscope, mechanical cleaning performed with round burs visualized under a clinical microscope. Then, fiberglass posts were cemented. The roots were prepared and evaluated by the push-out test. Data were analyzed using Kruskal-Wallis and Student-Newman-Keuls tests ($P < .05$). The failure pattern was classified as follows: adhesive between the cement and dentin, adhesive dentin/cement/post, mixed cohesive within dentin, mixed cohesive post, and mixed cohesive post/dentin. **Results:** The bond strength values (mean $\pm$ standard deviation) were control (cervical 1.17 $\pm$ 1.1, middle 0.40 $\pm$ 0.3, apical 0.52 $\pm$ 0.3, and total 0.95 $\pm$ 1.9), cleaning without a microscope (cervical 1.66 $\pm$ 2.3, middle 0.65 $\pm$ 1.1, apical 0.79 $\pm$ 1.2, and total1.04 $\pm$ 1.7), and cleaning with a microscope (cervical 3.26 $\pm$ 2.8, middle 1.97 $\pm$ 3.5, apical 1.85 $\pm$ 4.1, and total 2.37 $\pm$ 3.5). In the cleaning with a microscope group, the bond strength values were significantly higher than those in the other groups. In all groups, the main failure pattern was adhesive between cement and dentin. **Conclusions:** The use of a clinical microscope while performing mechanical cleaning during post space preparation improved the bond strength of a fiberglass post to dentin. *(J Endod 2015;41:1311–1316)*

Key Words

Bond strength, clinical microscope, mechanical cleaning, post space walls

Fiberglass posts have good esthetic appearance with no risk of gingival discoloration or alteration of the root surface by corrosive products, especially in the anterior region (1). Furthermore, they have a high flexural strength and an elastic modulus similar to that of dentin, thus minimizing the transmission of stresses to the root walls and decreasing the possibility of root fractures (2, 3). Failures of fiber posts and core restorations often occur through decementation between fiber post–resin and/or resin–root canal dentin interfaces (4).

The insertion of fiberglass posts requires resin-based adhesive materials. An effective, durable bond of the fiber post to root dentin and adhesive/resin cement is essential for the longevity of restorations (5). However, post luting is often complicated by the difficulty of the light from the curing unit reaching the most apical regions (6, 7) or the incompatibility between acid adhesives and self-/dual-polymerized composites (8). In addition, problems may result from high polymerization contraction stresses (9), moisture control for adhesion (10), and the peculiar characteristics of the root dentin substrate (11). To achieve high bond strength to the root canal walls, the smear layer and debris on the post space walls must be removed (12). However, some studies have reported difficulty in completely removing root canal filling materials, including gutta-percha and sealer, to obtain properly cleaned dentin surfaces (13–15).

The clinical microscope has increasingly been used *in vivo* for routine endodontic procedures because it provides enhanced visibility because of its magnification and illumination (16). Additionally, Perrin et al (17) evaluated the impact of loupes and microscopes on vision in endodontics. They observed that only the use of a microscope allowed the observation of structures inside the root canal independent of the dentist's age. The reported advantages of using a microscope for conventional endodontic treatment include improved visualization of the root canal anatomy, enabling the operator to investigate the root canal system, and the ability to clean and shape it more efficiently. Furthermore, the clinical microscope has been used to detect remnants after cleaning and shaping of retreatment cases (18). However, no study evaluated the influence of the use of a clinical microscope during the cleaning of post space walls on the bond strength of fiberglass posts cemented to dentin.

Thus, the aim of the present study was to evaluate the influence of a clinical microscope used while performing mechanical cleaning of post space walls on the bond strength of fiberglass posts to dentin. The null hypothesis put forward was that neither the use of a clinical microscope nor the different levels of root canal influence the retention of fiber posts.

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Materials and Methods

Specimen Preparation

Forty-five bovine teeth were used in the present study. The inclusion criteria were the existence of straight roots with similar length; round internal anatomy; diameter equivalent to that of Gates Glidden burs (GG) between nos. 3 and 5; and absence of root resorption, fracture, and cracks.

The crowns were removed and the roots standardized by cutting with a double-face diamond disk (KG Sorensen, Barueri, SP, Brazil), to obtain 14-mm-long roots. The pulp tissue was removed using a size 30 Hedströem file (Dentsply Maillefer, Ballaigues, Switzerland).

A step-back technique was used to shape all root canals. To prepare the middle cervical third, GG 5 was used at 5 mm and GG4 at 8 mm. The K3 (SybronEndo, Orange, CA) sequence used in the apical preparation was 15/.06, 20/.06, 25/.06, 30/.06, 35/.06, and 40/.06. Between files, the canals were irrigated with 1 mL 5.25% sodium hypochlorite (VisNature, Itajaí, SC, Brazil); 1 mL 17% EDTA (VisNature, Itajaí, SC, Brazil) was applied for 1 minute to remove the smear layer followed by rinsing with 5 mL saline solution and drying with medium-sized absorbent paper cones (Konne; Belo Horizonte, MG, Brazil). The canals were filled with medium-sized gutta-percha cones (Ícone, Belo Horizonte) and Pulp Canal Sealer (SybronEndo). All the canals were filled using a continuous wave of condensation technique.

After this, the roots were randomly divided into 3 groups ($n = 15$) according to the post space preparation. The same dentist, who is over 40 years of age, performed all of the procedures.

Control Group: Conventional Preparation. For post preparation, a heat condenser (Paiva condenser; Golgran, São Paulo, SP, Brazil) was used at 10 mm. Next, a Gates Glidden no. 5 bur was used at 8 mm, and a specific bur of the post system (White Post DC #2; FGM, Joinville, SC, Brazil) with dimensions similar to a fiberglass post (height 20 mm, higher and lower diameter 1.8 mm and 1.05 mm, respectively) was used at 10 mm.

After this, the post space was cleaned with 70% alcohol using a microapplicator followed by copious irrigation with saline solution. The canals were dried with paper cones (Konne, Belo Horizonte). All procedures were performed under reflector lighting.

Cleaning without a Microscope Group: Conventional Preparation Plus Cleaning Using Round Burs. After the post preparation procedure described in the control group, a 20:1 reduction system (EndoMate DT; NSK, Tochigi, Japan) at a speed of 500 rpm and a torque of 0.8 N associated with round burs was used. Round burs #4 (1.4-mm diameter), 2 (1.0-mm diameter), and 1 (0.8-mm diameter) were used circumferentially on the dentin surface at 3 mm, 6 mm, and 10 mm, respectively. After this, the same post space cleaning protocol described in the control group was used. As described earlier, procedures were performed under reflector lighting.

Cleaning with a Microscope Group: Conventional Preparation Plus Cleaning Using Round Burs under a Clinical Microscope. The same procedure described in the cleaning without a microscope group was used under a clinical microscope (MC-M2101; DF Vasconcelos, São Paulo, SP, Brazil) at 8.0× magnification.

The fiberglass posts (White Post DC #2) were cleaned with 37% phosphoric acid (Condac 37, FGM) for 10 seconds, washed with distilled water, and dried. Silane (FGM), a chemical bonding agent, was applied for 1 minute and dried with air jets. Adhesive (Kuraray, Osaka, Japan) was applied and photoactivated for 10 seconds.

For dentin treatment, adhesive procedures were performed using the Clearfil SE Bond (Kuraray, Osaka, Japan) system. Acid primer was applied on the dentin walls using a microapplicator for 20 seconds and dried with an air jet, and paper points (Konne, Belo Horizonte) were used to remove the excess primer. Clearfil SE Bond was applied with a microapplicator followed by an air jet to standardize the layer, and absorbent paper was used to remove the excess bonding material. After this, light polymerization (Radii-cal 1200 mW/cm^2; SDI Limited, Bayswater, Victoria, Australia) was performed for 10 seconds. All adhesive procedures were performed according to the manufacturer recommendations. This procedure was performed without a microscope.

The resin cement (RelyX ARC; 3M ESPE, St Paul, MN) was manipulated and placed into the canal using 20-G Accudose Needle Tubes (Centrix; DFL, Rio de Janeiro, RJ, Brazil). Posts were placed in position immediately after the cement application. After 5 minutes (time of chemical polymerization), light polymerization was performed for 40 seconds on each surface (mesial, buccal, distal, and lingual) (19).

Push-out Test and Failure Mode Analysis

In each group, 2 samples were used to illustrate the mechanical cleaning (Fig. 1). Grooves were made parallel to the long axis on the buccal and lingual surfaces of the teeth, which were split into halves. They were observed under a stereoscope (Carl Zeiss, Thornwood, NY) at 10× magnification.

For the push-out test and failure mode analysis, 13 samples per group were used. Each root was horizontally sectioned with a slow-speed, water-cooled diamond saw (Isomet 2000; Buehler, Lake Bluff, IL) to produce 2 slices approximately 1-mm thick of each root region (ie, apical, middle, and coronal). The first (coronal) and last (apical) slices were discarded. Six slices from each root canal were evaluated.

The push-out test was performed using a cylindrical stainless steel plunger 1 mm in diameter to apply a load at 0.5 mm/min from the apical to coronal direction until the post segment was dislodged from the root section. The push-out bond strength was measured with a universal testing machine (EMIC DL 2000; São José dos Pinhais, PR, Brazil). To express the bond strength in megapascals (MPa), the load at failure recorded in newtons was divided by the area (mm^2) of the post-dentin interface. To calculate the bonding area, the formula π (R + r) $[h^2 + (R - r)^2]^{0.5}$ where R represents the coronal root canal radius, r the apical root canal radius, and h the thickness of the slice was used. 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 30× magnification with a stereoscope (Carl Zeiss) and ImageLab 2.3 software (University of São Paulo, São Paulo, SP, Brazil) (3). Push-out bond strength data were analyzed using the Kruskal-Wallis and Student-Newman-Keuls tests ($P < .05$).

All fractured specimens were observed under a stereoscope (Carl Zeiss) at 30× magnification and scanning electron microscopy (JSM 6460 LV; JEOL, Tokyo, Japan) from the cervical direction and the apical direction to determine the failure mode. The failure mode was classified into 5 types:

1. *Adhesive between the cement and dentin*: Fracture occurs predominantly at the cement/dentin interface
2. *Adhesive dentin/cement/post*: Fracture occurs without predominance of an interface
3. *Mixed cohesive dentin*: Some fracture occurs within dentin
4. *Mixed cohesive post*: Fracture occurs at the post
5. *Mixed cohesive post/dentin*: Fracture occur at the post and dentin
   The evaluation was performed by a single experienced evaluator.