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Influence of calcium hydroxide intracanal medication on bond strength of two endodontic resin-based sealers assessed by micropush-out test

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Abstract – *Aim:* To evaluate the influence of calcium hydroxide (CH) paste used as intracanal medication on the bond strength of AH Plus (AH) and Epiphany (EP) sealers to root dentin. *Methodology:* Sixty palatal canals were prepared in human maxillary first molars, using a rotary system. Half of the specimens received distilled water, and the other ones received intracanal medication with CH for 14 days. Thereafter, the CH was removed and both groups were further divided into two subgroups, filled with either AH or EP. The test specimens were submitted to the micropush-out test at a speed of 0.5 mm min^{-1}. Results were statistically analyzed with ANOVA and Tukey's test at a 95% confidence level. *Results:* The use of CH had statistically significant ($P < 0.05$) influence on AH only, increasing its bond strength from 19.7 ± 4.5 to 23.8 ± 2.5 (mean ± SD in MPa). In both EP groups, with (1.8 ± 0.5 MPa) and without (1.5 ± 0.9 MPa) CH, the bond strength values were statistically significantly lower than in either of the AH groups ($P < 0.05$). *Conclusion:* Calcium hydroxide used as intracanal medication for 14 days had a positive influence on the bond strength of AH to root dentin whereas the effect on EP was insignificant. Regardless of the intracanal medication used, AH showed considerably higher bond strength values compared with EP sealer.

To achieve successful endodontic treatment, complete filling of the root canal system with biocompatible and dimensionally stable filling materials is an important factor (1). However, despite the large number of techniques and materials available (2–4), it is still a challenging task to completely fill the root canal. Adhesive bonding and resin sealers have been developed for endodontic use and may improve root canal filling (5). These materials require prior and specific treatment for dentin filling that consists of a single-cone monoblock of material resulting from the chemical bond of the filling cone and the chemical–mechanical interaction with the dentinal substrate (6, 7).

For endodontic use, a sealer must adhere to dentin to prevent bacterial leakage (8). One of the factors that may influence this bond is the nature of irrigant solutions and intracanal medications, as these may interfere with adequate sealing of the endodontic system (8–12).

Calcium hydroxide (CH) is a widely accepted intracanal medication because it has a number of desirable properties, such as the ionic dissociation of CH into calcium ions and hydroxyl ions. The effects of these ions on the tissues and microorganisms have popularized its use (13). There is consensus that CH must be removed before filling root canals; however, its complete removal from the root canal is problematic (14–20).

The residues of CH used as intracanal medication, which probably remain in the entrance to the tubules and on the dentinal walls, may affect resin monomer penetration into the dentinal tubules and interfere negatively in the formation of the hybrid layer of an endodontic adhesive filling system (4, 21).

The influence of CH on the apical seal was first shown by Porkaew et al. (9) and Holland et al. (10), who found less dye leakage in roots filled with gutta-percha and zinc oxide–eugenol (ZOE)-based sealer after intracanal CH medication. However, Pasqualini et al. (11), who assessed the microbial leakage, found the effect of CH medication to be insignificant for both ZOE and Epiphany (EP) sealer groups.

Barbizam et al. (12), by using push-out test found lower bond strength of EP in both CH medication groups, regardless whether the powder was mixed with water or chlorhexidine. However, there are no previous studies about the influence of intracanal medication on the performance of AH Plus (AH) sealer.

Thus, the aim of this study was to evaluate the influence of CH paste used as intracanal medication on the bond strength to root dentin of the AH and EP sealers.

Materials and methods

After approval from the Research Ethics Committee of the São Paulo University, 60 recently extracted human maxillary first molars with completely formed apices and straight roots were selected. The teeth were cleaned, and the palatal roots were sectioned perpendicular to the long axis of the tooth, in the proximities of the cemento-enamel junction, with the length standardized to 16 mm. The real working length was determined, using a stereoscopic loupe at 25× magnification (Baush, Lomb, Rochester, NY, USA). At this magnification, when the tip of a file was visualized in the vicinity of the apical foramen, 1 mm was withdrawn from the measurement obtained.

The canal was debrided using a 1% sodium hypochlorite solution (Fórmula & Ação, São Paulo, SP, Brazil) and rotary instrumentation with the EndoSequence system (Brasseler, Savannah, GA, USA), the last instrument used being the 40.04. At each change of rotary system instrument, the canals were irrigated with 0.5 ml of 1% sodium hypochlorite solution.

The smear layer was removed by irrigating the canal with 5 ml of 17% EDTA solution (Fórmula & Ação, São Paulo, SP, Brazil) for 3 min followed by 15 ml of physiologic solution. After this, the canals were dried with suction cannulas with diameters decreasing in size and absorbent paper points.

After chemo-mechanical preparation, the roots were randomly divided into two groups (30 each) either receiving (CH+) or not (CH−) the intracanal medication with CH (Fórmula e Ação, São Paulo, SP, Brazil). The CH+ group received intracanal medication that was manipulated using distilled water until a creamy consistency (1:1.5, w/v) (17). This paste was inserted with the aid of a lentulo spiral, and cervical sealing was performed with glass-ionomer cement. The remaining 30 canals were left without CH (forming CH- group) and were filled with distilled water, and the cervical portion was sealed in the same manner. Thereafter, all 60 roots were stored for 14 days at 37°C and 100% relative humidity.

The 30 canals that received CH medication were opened again, and the medication was removed by irrigation with 5 ml of 1% sodium hypochlorite under ultrasonic agitation (NSK Varios 350; NSK, Tochigi, Japan) with file #15 for 30 s at low power (mode 1). After this, the canals were irrigated with 5 ml of 17% EDTA for 3 min, followed by 15 ml of physiologic solution.

The apical and cervical 2 mm of all the specimens were cut off and discarded. The remaining root was thereafter cut into four 1.5-mm thick slices in an Isomet 100 Precision Saw (Buehler Ltd, Lake Bluff, IL, USA) cutting machine under constant cooling. The thickness of slices was measured with a digital caliper with accuracy of 0.01 mm (Mitutoyo MTI Corporation, Tokyo, Japan).

The four slices from each root were placed in individual vials immersed in physiologic solution at 37°C for 48 h. Afterward, the specimens were further randomly divided into AH (AH Plus™ Maillefer; Dentsply Ind. e Com. Ltd, Petrópolis, RJ, Brazil) and EP (Epiphany™; Pentron Clinical Technologies, Wallingford, CT, USA) subgroups, finally comprising four study groups: AHCH−, AHCH+, EPCH−, and EPCH+. The slices were dried, and the canal lumen was filled with the aid of a Centrix syringe (DFL, Rio de Janeiro, RJ, Brazil) and nano tips (Ultradent Products; South Jordan, UT, USA) according to the internal diameter of the slices with endodontic sealer only, without the use of gutta-percha or Resilon™ (Pentron Clinical Technologies, Wallingford, CT, USA) points. For the AH groups, only polyester strips were placed over the slices after filling, and a glass plate was put onto this set, so that there would be no extravasation of sealer out of the root canal.

In EP groups, the slices were joined and insulation tape was wrapped around them. It was only after this procedure that the sealer was light activated for 40 s with a JetLite appliance model 4000 Plus (J. Morita Inc., Irvine, CA, USA) at irradiance of 600 mW cm^{-2} checked with a radiometer (total energy dose of 24 J cm^{-2} Optilux Sybron Kerr, Middleton, WI, USA) in the most exposed cervical portion, simulating clinical conditions. The test specimens were kept in a vacuum chamber at 37°C and 100% humidity for 7 days.

On both sides of the slices, digital images were captured with a digital camera (Q-Color 5; Olympus, America Inc., PA, USA) coupled to a stereomicroscopic loupe (SZ61; Olympus America Inc., PA, USA), at 40× magnification, and the apical and cervical internal diameters were measured using IMAGE J software (National Institute of Health, Maryland, EUA http:/rsb.info.nih.gov/ij/).

After storage, the cervical surface of each test specimen was placed in the support coupled to the base of the Universal test machine (Kratos Dinamômetros, Embu, SP, Brazil). The postdiameter was selected so that it was 0.2 mm smaller than the apical diameter of the slice, to prevent it from touching the dentinal walls during the test.

The apical aspect of the each specimen was positioned facing the punch tip. Loading was performed at a crosshead speed of 0.5 mm min until the sealer was dislodged from the root slice. Tensile bond strength of each slice was calculated as the force (N) of failure divided by the bonded cross-sectional surface area and expressed in MPa (22).

Statistical analysis

In this test, the sample unit was defined as being each one of the roots used. Therefore, the arithmetic mean of the bond strength values of the test specimens that came from the same tooth was calculated.

The data were submitted to the two-way analysis of variance (ANOVA) for two factors and Tukey's test for the contrast among means, at a 95% confidence level.

Results

The ANOVA demonstrated that the interaction of the factors was significant ($P = 0.003$). The use of CH had statistically significant (Tukey's test; $P < 0.05$) influence on AH, increasing its bond strength from 19.7 ± 4.5 to 23.8 ± 2.5 (mean ± SD in MPa), see Fig. 1. The EPCH+ (1.8 ± 0.5 MPa), and EPCH− (1.5 ± 0.9 MPa) groups did not statistically differ from each other, and the bond strength values in these groups were significantly lower than in either of the AH groups ($P < 0.05$).

Discussion

Thus, in this research, the aim was to evaluate whether CH paste used as intracanal medication could influence the bond strength of the endodontic sealer to root dentin, by means of the micropush-out test.

Although several studies (19–21) have observed that CH reduces dentinal permeability by physically blocking the dentinal tubules, it appears that in this study CH did not negatively influence the bonding of EP, as in the CH group the strength values were slightly higher compared with the control, although this increase was not statistically significant. This results is in line with that of Wang et al. (8), who also found Resilon-EP system to perform better when CH had been used, although their result was neither statistically significant. But this is in contrast with the study by Barbizam et al. (12), who evaluated the bond strength of EP to the dentinal walls after the application of CH pastes and showed a significant decrease in the bond strength values when CH pastes were used. However, the overall high bond strength values from EP in their study, exceeding 10 MPa, differ from the majority of studies conducted with EP, in which these values start at 0.32 MPa but seldom exceed 6 MPa (20, 23–30).

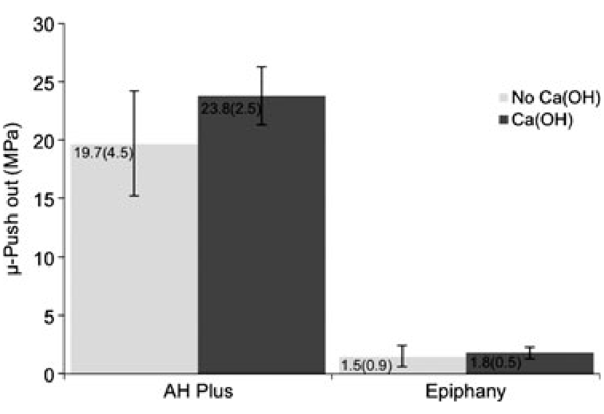

Fig. 1. Means and 95% confidence intervals (vertical bars) of micropush-out bond strength values (MPa) of two resin-based sealers to dentin with and without 14 days of intracanal CH dressing. Different letters indicate statistically significant differences at a 95% confidence level ($P < 0.05$).

Porkaew et al. (9) reported that residual CH on the root canal walls may increase root dentin sealing. The explanation given by the authors was that CH can incorporate into the sealer, causing diminished permeability. Holland et al. (10) noted that there was less leakage in the experimental groups that received CH dressings than in the control groups. The results persisted even after the removal of 300 micrometers of dentin from the root canal dentinal walls.

Also, Pasqualini et al. (11) studied the sealing of EP and ZOE-based sealer, making use of a microleakage model, and observed that CH had no relevant impact on the quality of apical sealing of the two materials. Nevertheless, in the groups that were filled with EP, there was greater microleakage.

In this study, the sealer bond strength results for EP (1.5 and 1.8 MPa) are comparable with those of other studies that showed values ranging between 0.32 and 6.3 MPa (17, 22–29).

As regards the high bond strength values of AH, the results of this study are in agreement with various studies in which higher values were recorded for the association AH/gutta-percha and the lowest for the EP system (24, 30–32). Another explanation for this better bond would be the formation of a covalent bond between the epoxy group of AH and the amine group of the exposed dentinal collagen (24).

Another area for discussion was the choice of testing only the sealer, and not the sealer/gutta-percha set. Although filling the root canal with sealer only does not represent the clinical situation, this experimental model was chosen because the gutta-percha, being the weakest link of the bond in the filling set, tends to give way first under load application. This affirmation was confirmed by Jainaen et al. (32) who evaluated the influence of the main cone on the bond strength of AH or other methacrylate-based sealer to root dentin and observed that the bond strength values were to the order of 2–8 times higher for canals filled with sealer only.

Further studies are still necessary to demonstrate whether residual CH could act in impeding a satisfactory bond in some regions of the canal or whether this medication could in some way benefit the sealing of endodontic fillings.

Conclusions

Calcium hydroxide used as intracanal medication for 14 days had a positive influence on the bond strength of AH to root dentin whereas the effect on EP was insignificant. Regardless of the intracanal medication used, AH showed considerably higher bond strength values compared with EP sealer.

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