Push-out Bond Strength of Resilon/Epiphany and Resilon/Epiphany Self-Etch to Root Dentin

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Abstract

Introduction: The present study was designed to investigate the bond strength produced by Epiphany and Epiphany SE to root canal dentin. Methods: A sample of 36 human upper canines was prepared and assigned to experimental groups (n = 12), designated as group 1, Resilon/Epiphany; group 2, Resilon/Epiphany SE; and group 3, AH Plus/gutta-percha. After the filling procedures, each tooth was prepared for push-out assessment by using root slices of 1-mm thickness. Loading was performed on a universal testing machine at a speed of 0.5 mm/min. One-way analysis of variance and Tukey test for multiple comparisons were used to compare the results among the experimental groups. Results: AH Plus/gutta-percha root fillings showed significantly higher push-out bond strength than both Resilon/Epiphany and Resilon/Epiphany SE (P < .05). There was no significant difference between Epiphany/Resilon and Epiphany SE/Resilon (P > .05). Conclusions: Under the present in vitro conditions, the adhesiveness quality to root dentin promoted by both Epiphany sealers is compromised even when teeth with simple anatomic features were obturated under well-monitored laboratory conditions. (J Endod 2009;35:1048–1050)

Key Words

Push-Out Bond Strength, Resilon, Epiphany, Adhesiveness, root dentin, root filling, endodontics

Despite its good preliminary results (1–4), the suboptimal condition of root dentin adhesive technology has recently been addressed by a series of well-conducted studies (5–8). In a noteworthy review, Schwartz (9) highlighted the critical conditions for an optimal intraradicular bonding or, in other words, an effective bonding in the environment of the root canal system. This must be considered as a real challenge because of the anatomic factors linked to the well-known limitations of the current dentin adhesive materials. Considering these challenges and limits, the effectiveness of adhesive root fillings is currently under scrutiny. Therefore, alternative strategies and new adhesive sealer generations have been introduced with the clear purpose of compensating for the above mentioned limitations and producing a reliable fluid-tight seal root filling.

A few years ago, a new resin-based cement was developed and introduced to the dental market as self-adhesive universal resin cement (Rely X UniCem; 3 M ESPE Dental Products, St Paul, MN). This type of cement combines the use of adhesive and cement in one single application. The manufacturer states that the cement is a paste/paste, fluoride-releasing, and radiopaque dual-cured resin luting cement that is formulated for luting crowns, bridges, inlays, onlays, and posts (10, 11). In addition, the fact that the self-adhesive resin cement is thought to bond to dentin without any kind of conditioning or pretreatment is a point that must be considered (10, 11). This provides the need for a large body of scientific investigation around the self-adhesive resin cement. Recently, a new version of the Epiphany sealer, based on the self-adhesive cement concept, was introduced with the promise of optimizing the clinical performance with a simplified application procedure. In this way, the manufacturer created the hypothesis that the new Epiphany self-adhesive sealer (Epiphany SE; Pentron Clinical Technologies LLC, Wallingford, CT) could bond simultaneously to both radicular dentin and Resilon points (12). Hence, the present study was designed to investigate the bond strength produced by Epiphany and Epiphany SE to root canal dentin. The conventional nonbonding AH Plus/gutta-percha root filling was used as a reference for comparison. The push-out test was used to test the null hypothesis that there is no difference in the push-out bond strength produced by Epiphany, Epiphany SE, and AH Plus.

Materials and Methods

Sample Selection and Specimen Preparation

A sample of 36 extracted human upper canines with straight roots and 20 ± 1 mm in length were selected. This study was revised and approved by the Ethics Committee, Nucleus of Collective Health Studies of Veiga de Almeida University. The teeth were disinfected in 0.5% chloramine-T, stored in distilled water at 4°C, and used within 6 months after extraction. Standard access cavities were made, and all the canal orifices were located. The patency of each canal was confirmed, and the working length was established by deducting 1 mm from the canal length. The root canal was prepared with the conventional sequence of ProTaper Universal NiTi rotary (DENTSPLY Tulsa Dental, Tulsa, OK) until the finisher F4 instrument achieved a 0.4/0.06 apical taper. All canals were irrigated between each file with 0.5 mL of freshly prepared 2.5% NaOCl. The smear layer was removed with 3 mL of 17% ethylenediaminetetraacetic acid for 3 minutes. A 5-mL flush of bi-distilled water was used as a final rinse.

The use of different root-filling materials resulted in 3 experimental groups (n = 12) that were randomly distributed with the aid of a free computer algorithm (http://www.random.org).
Canal Filling

For all specimens, an ISO size 40 file was used to place sealer in large quantity (9, 10). In group 1, a prefilled 0.4/0.06 gutta-percha cone (Diadent Group International, Chongchong Buk Do, Korea) was used with AH Plus sealer (Dentsply-Maillefer, Ballaigues, Switzerland). The gutta-percha cone was inserted into the full working length, and lateral compaction was achieved by using 5 accessory gutta-percha cones (Diadent) and endodontic finger spreader size B (Maillefer). A heated instrument was used to cut the coronal surplus, after which the filling was vertically compacted. In group 2, Epiphany primer was introduced into the root canals with the aid of a microbrush, and a prefit size 0.4/0.06 taper Resilon cone (Pentron Clinical Technologies LLC) was used in the same manner described for group 1. In group 3, Epiphany SE was used in the same manner described for group 1. To create the immediate coronal seal in the adhesive root-filling groups, all specimens in group 2 and group 3 were light-cured for 40 seconds with a Coltolux LED curing light (Coltene Whaledent Product, Cuyahoga Falls, OH). The filled roots were stored at 37°C and 100% humidity for 14 days to allow setting of the sealers.

Push-out Assessment

Each root was horizontally sectioned into four 1 ± 0.1 mm thick serial slices by using a low-speed saw (Isomet; Buehler, Ltd, Lake Bluff, NY) with a diamond disk (0.125 × 0.20 × 12.7 mm; 330C) under continuous water irrigation. The thus-created 4 slices per root resulted in 48 slices/group or 24 slices per root segment (middle and apical).

The thickness of each slice was measured with a digital caliper to an accuracy of 0.001 mm (Avenger Products, North Plains, OR), and it was always within the 0.9–1.1 mm range. Then both apical and coronal aspects of the specimens were microscopically examined to confirm a circular canal shape. The fine-tune parallelism was ensured by a laser beam device, and the root filling of each sample was loaded with a 0.5-mm-diameter cylindrical plunger. The plunger tip was sized and positioned to touch only the root filling. The load was always applied in an apical-coronal direction to avoid any constriction interference as a result of root canal taper during push-out testing. Loading was performed on a universal testing machine (EMIC DL200MF, São José dos Pinhais, PR, Brazil) at a speed of 0.5 mm/min until debonding occurred. A load × time curve was plotted during the test by using a real-time software program. To express the bond strength in megapascals, the load at failure recorded in newtons was divided by the area of the bonded interface. The operator who made the measurements was blinded as to which samples were matched to which materials.

Statistical Analysis

The preliminary analysis of the raw pooled data revealed a bell-shaped distribution (D'Agostino & Person omnibus normality test). Further statistical analysis was performed by using one-way analysis of variance (ANOVA); Tukey test for multiple comparisons was used to isolate the differences. The alpha-type error was set at 0.05. SPSS 11.0 (SPSS Inc, Chicago, IL) and Origin 6.0 (Microcal Software, Inc, Northampton, MA) were used as analytical tools.

Results

All specimens showed lower but measurable adhesive properties to root dentin. In addition, no premature failure occurred. The group-by-location interaction was not significant (P = .79); therefore, the group comparisons were not dependent on the root canal third. As a consequence, all data were pooled to provide a single mean and standard deviation per root filling material, averaging the 12 teeth per group.

AH Plus/gutta-percha root fillings showed significantly higher push-out bond strength than both Resilon/Epiphany and Resilon/Epiphany SE (P < .05). There was no significant difference between Epiphany/Resilon and Epiphany SE/Resilon (P = .91). Box plots illustrating the mean, minimum, and maximum values as well as the variance of the push-out bond strength data in each experimental group are shown in Fig. 1.

Discussion

As a consequence of the current results, the null hypothesis was rejected. Essentially, it means that the present result displays no advantage in the use of the adhesive root fillings as a result of the significantly lower push-out bond strength demonstrated by both Resilon/Epiphany and Epiphany SE groups. This is a contradictory situation because the nonadhesive root fillings obtained a superior adhesiveness than both adhesive root-filling materials. Thus, the endodontic mono-block cannot be produced by the tested adhesive root-filling materials.

The present findings are in accordance with some recent reports that have used a similar study design and revealed unenthusiastic results for the traditional Resilon/Epiphany root fillings (8, 13, 14). The adhesive root fillings were able to provide just a suboptimal bonding quality to root dentin. A well-controlled study demonstrated that Resilon/Epiphany combination showed lower bond strength than AH Plus sealer and gutta-percha (8). The result was similar to the findings of Gesi et al (14), who used a closed push-out experimental model. Recently, the bond strength of AH Plus and Epiphany sealers to root dentin treated with different irrigation solutions was evaluated, and the authors concluded that the epoxy sealer presented greater adhesion to dentin than Epiphany, regardless of the treatment of root canal walls (15). Fisher et al (16) theorized that one potential explanation for the superior adhesiveness to root dentin shown by AH Plus can be based on the creation of a covalent bond by an open epoxide ring to exposed amino groups in the collagen network.

It is worthwhile to mention that even the root canals filled with the new Epiphany SE have shown lower bond strength. Essentially, the push-out bond strength of Epiphany SE was comparable to that of the traditional Epiphany. It is evident that these similar results are in favor of Epiphany SE as a result of its simplified application procedure. To the best of our knowledge, there is no further peer-reviewed information about the performance of the Epiphany SE sealer. Thus, it was not

Figure 1. Box plots of the push-out strength data. Letters indicate significant statistical differences between groups; P < .05.
possible to establish a comparison between the present results of Epiphany SE sealer and previous literature.

On the basis of well-designed adhesive dentistry studies, the message from the accumulated scientific knowledge is clear; an effective bonding to a wet substrate such as root dentin is still a difficult task (9, 17–23). The root canal system has a well-known unfavorable geometry for resin bond bonding. Therefore, a more plausible explanation for the results achieved in the present study is presented; it is a recognizable fact that methacrylate-based materials undergo volumetric shrinkage during the polymerization process (9, 18, 19). The high C-factor of the root canal space can be blamed as the key factor related to polymerization stresses created by resin-based adhesives (9, 17–23). In fact, significant volumetric polymerization shrinkage of the adhesive sealer is incompatible with an optimal bonding condition to the root dentin.

From a practical standpoint, close examination of the present results yields an interesting thought for further consideration; despite the theoretical development reached by the introduction of current dentin adhesive technology to be used for root-filling procedures, the simple and cost-effective nonbonding root fillings are still the more reliable choice. Moreover, the adhesiveness quality to root dentin promoted by both Epiphany sealers is compromised even when teeth with simple anatomic features were obturated under well-monitored laboratory conditions. The higher push-out bond strength found in the AH Plus/gutta-percha root fillings reiterates the fact that the era of conventional nonbonding root filling has not yet come to an end.

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**References**