Influence of Ultrasonic Activation of 4 Root Canal Sealers on the Filling Quality

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Abstract

Introduction: The purpose of this study was to evaluate the effects of ultrasonic activation on the filling quality (intratubular sealer penetration, interfacial adaptation, and presence of voids) of 4 epoxy resin–based sealers. **Methods:** Eighty-four extracted human canines were divided into 4 groups (n = 20) according to the sealer used to obturate the root canals instrumented with F5 ProTaper instruments (50/05) (Dentsply Maillefer, Ballaigues, Switzerland). The canals were filled by the lateral compaction technique. Previously, the sealers were labeled with rhodamine B dye to allow analysis under a confocal microscope. At the time of obturation, the specimens were divided again into 2 groups (n = 10) according to the ultrasonic activation of the sealers: ultrasonically activated and nonultrasonically activated groups. All samples were sectioned at 2, 4, and 6 mm from the apex. The percentages of voids, gaps, and dentinal sealer penetration segments of the canal were analyzed. **Results:** Regarding the sealer penetration segments, there was a significant increase for the AH Plus (Dentsply Maillefer), Acroseal (Specialités Septodont, Saint Maur-des-Fossés, France), and Sealer 26 (Dentsply Maillefer) at the 4-mm level and the AH Plus and Sealer 26 at the 6-mm level with ultrasonic activation (P < .05). Concerning the gaps, the ultrasonic activation promoted a smaller presence for all sealers at the 4- and 6-mm levels (P < .05). No statistical significant differences were found for the percentages of voids (P < .05). **Conclusions:** The use of ultrasonic activation of an epoxy resin–based sealer promoted greater dentinal sealer penetration and less presence of gaps. *(J Endod 2014;40:964–968)*

Key Words

Confocal microscopy, epoxy resin sealers, root canal filling, ultrasound

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The complete sealing of the root canal system after a biomechanical procedure can determine the long-term success of an endodontic treatment by preventing oral pathogens from colonizing and reinfecting the root and periapical tissues (1, 2). Because gutta-percha does not adhere to the dentinal walls, the sealer must fill the irregularities and the dentinal tubules of the root canal system.

Epoxy resin–based sealers were introduced in endodontics by Schroeder (3) and have since been used because of their reduced solubility (4), apical seal (5), and microretention to the root dentin (6). One of these sealers is AH Plus (Dentsply Maillefer, Ballaigues, Switzerland), which has been extensively evaluated for its physicochemical properties, biological response, and interfacial adaptation (7–9). The Adseal (Meta Biomed, Cheongju, South Korea) is another epoxy resin sealer with reports in the literature about its radiopacity value and physical properties (9, 10). Acroseal (Specialités Septodont, Saint Maur-des-Fossés, France) is a sealer that contains 28% calcium hydroxide in its composition. Previous studies have shown its sealing ability, antimicrobial activity against *Enterococcus faecalis*, and adaptation to the root canal walls (9, 11, 12). Sealer 26 (Dentsply Maillefer) is an epoxy resin–based material containing calcium hydroxide and has also shown good sealing ability and antimicrobial activity (13, 14).

Ultrasound is an instrument that was first introduced to endodontics by Richman in 1957. Currently, it has been widely used in different endodontic procedures, ranging from coronal opening to endodontic surgery (15). A greater agitation of irrigating solutions promoted by ultrasound intensifies the penetration in an area of anatomic complexity such as the dentinal tubules and consequently improves the cleaning ability (16). The activation of root canal sealers can possibly favor its penetration inside the dentinal tubules, providing an increase in sealability (17) and antimicrobial effects (18). The effects of ultrasonic activation of the sealer into the root canal and the filling quality have not been explored sufficiently.

The aim of this study was to evaluate the effect of ultrasonic activation on 4 epoxy resin–based sealers regarding their filling quality. The null hypothesis that was tested is that ultrasonic activation improves the filling quality of epoxy resin–based sealers.

Materials and Methods

Eighty-four maxillary human canines with a root curvature less than 5° were used (19). The ethics committee approved the use of extracted teeth for the research (CEP 079/2011). The crowns were removed at the cementoenamel junction using a 0.3-mm low-speed diamond saw (Isomet, Buehler, Lake Bluff, IL), and the root canal length was established at 15 mm. The working length was established by measuring the penetration of a size 10 K-file (Dentsply Maillefer) until it reached the apical foramen and then subtracting 1 mm. Root canal shaping was performed using ProTaper rotary instruments (Dentsply Maillefer) at the working length until a F5 (50.05) instrument. After the use of each instrument, the canals were irrigated using 2 mL 2.5% sodium hypochlorite. Passive ultrasonic irrigation was performed at the end of the shaping as described by van der Sluis et al (20). A final flush of 2 mL 17% EDTA (pH = 7.7) (Biodinâmica, Ibiporã, Paraná, Brazil) was applied for 3 minutes to eliminate the smear layer. Then, the canals were washed with 5 mL saline solution and dried with paper points (Dentsply Maillefer).

The specimens were randomly divided into 4 groups (n = 20) according to the sealer used to obturate the root canals:

Group 1: AH Plus (Dentsply Maillefer)
Group 2: Acroseal (Septodont, Saint Maur des Fosses, France)
Group 3: AdSeal (Meta, Biomed, Cheongju, South Korea)
Group 4: Sealer 26 (Dentsply Maillefer)

The sealers were manipulated according to the manufacturer's instructions. To allow visualization under a confocal laser microscope (TCS-SPE; Leica Microsystems GmbH, Mannheim, Germany), the sealers were mixed with fluorescent rhodamine B dye (Sigma-Aldrich, St Louis, MO) to an approximate concentration of 0.1% (21). The sealers were placed in each root canal by using a size 30 rotary lentulo spiral (Dentsply Maillefer), maintaining the instrument 4 mm from the apex. Then, the specimens were divided into 2 groups (n = 10) according to the ultrasonic activation of the sealers: ultrasonically activated (A) and nonultrasonically activated (NA) groups. The activation in group A was performed using a size A nickel-titanium finger spreader (Dentsply Maillefer) adapted into an ultrasonic device (Jet-Sonic Four Plus; Gnatus, Ribeirão Preto, SP, Brazil) in "endo" mode (50% potency) using a no. A-120 insert (Gnatus) (Fig. 1). Because the ultrasonic oscillates in a single plane, the spreader was activated for 20 seconds in the buccolingual direction and another 20 seconds in the mesiodistal direction of the root canal, 2 mm short of the working length as a standardization procedure. Next, a 50.02 gutta-percha cone (Dentsply Maillefer) was inserted into the full working length, and the root canal obturation was completed using the lateral compaction technique with a size B finger spreader (Dentsply Maillefer) inserted 2 mm short of the working length and accessory gutta-percha points size 20.02 (Dentsply Maillefer). The cervical portion of the specimens was sealed using a provisional filling material (Coltosol, Coltene, Switzerland). The specimens were stored in 100% humidity at 37°C for 1 week to allow the sealers to set.

Voids Area, Interfacial Adaptation (Gaps), and Segment of Sealer Penetration

The samples were sectioned using a 0.3-mm Isomet saw (Buehler, Lake Bluff, IL) at 200 rpm with continuous water cooling to prevent frictional heat. Horizontal sections were performed at the 2-, 4-, and 6-mm levels from the apical foramen and polished with sandpaper (Politriz; Arotec, Cotia, SP, Brazil). To calculate the void area (mm^2) percentages, a stereomicroscope (Stemi 2000C; Carl Zeiss, Jena, Germany) and the Axiovision software (Carl Zeiss) were used (Fig. 2*A*). First, the total area of each cross-section image of the canal and the visible voids were measured. With both values obtained, the percentage of voids in relation to the total area of each canal section was calculated.

The segments of the root canal in which the sealer penetrated into the dentinal tubules, and the interfacial adaptation (gaps) were analyzed on an inverted Leica TCS-SPE confocal laser scanning microscope (Leica Microsystems GmbH) by the similar method described by Moon et al (22). For the correct visualization of all images, the sections were analyzed 10 μm below the surface using the 10× lens. The respective absorption and emission wavelengths for the rhodamine B were set to 540 and 590 nm, respectively. Then, the images were recorded at 100× magnification using the fluorescent mode to a size of 1024 × 1024 pixels and a scale set to 100 μm (Fig. 2*B*). Analysis of all images was performed with the Image J V1.46r software (National Institutes of Health, Bethesda, MD). The total circumference of the canal was obtained first. Then, segments of sealer penetration into the dentinal tubules and interfacial adaptation (gaps) of the total circumference were measured, and the values were converted into percentages (Fig. 2*C* and *D*).

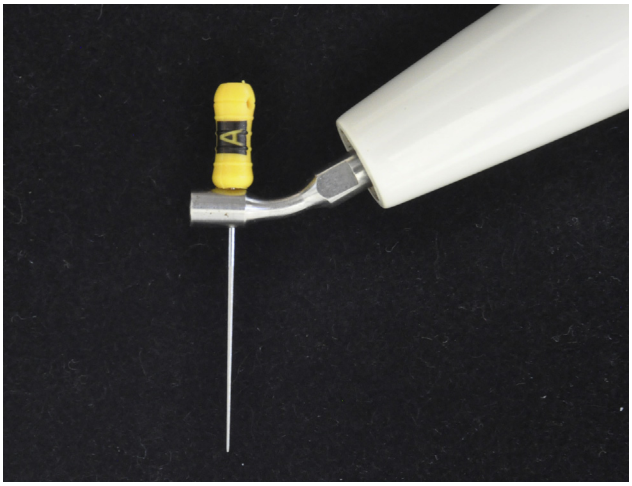

Figure 1. Finger spreader adapted into an ultrasonic device using a no. A-120 insert.

Statistical Analysis

Because of the absence of normal distribution, which was observed using the Shapiro-Wilk test. Statistical analysis was performed by using the nonparametric Kruskal-Wallis and Dunn tests (P < .05). The nonparametric Mann-Whitney test was used to analyze the influence of ultrasonic activation individually in each sealer (P < .05).

Results

Median and range of voids, interfacial adaptation (gaps), and dentinal sealer penetration segments of the canal can be found in Table 1. With regard to the sealer penetration segments, there was a significant increase for the AH Plus (Fig. 2*E* and *F*), Acroseal, and Sealer 26 at the 4-mm level, and the AH Plus and Sealer 26 at the 6-mm level when the ultrasonic activation was performed (P < .05). Regarding the gaps, the ultrasonic activation promoted a smaller presence for the AH Plus at the 2-mm level and for all sealers at the 4- and 6-mm levels (P < .05). The voids percentage revealed no significant differences between the A or NA groups at all levels (P < .05).

Discussion

The null hypothesis tested was confirmed because the ultrasonic activation improved the filling quality of the 4 epoxy resin–based sealers. The transmission of acoustic microstreaming energy from an oscillating file by the use of ultrasonic activation can promote the penetration of irrigants in an area of anatomic complexity and the dentinal tubules, resulting in a greater cleaning ability (16). With regard to the intracanal medication, Duarte et al (23) analyzed the influence of ultrasonic activation of calcium hydroxide pastes on the pH and calcium release in simulated external root resorptions. The authors showed that the ultrasonic activation favored a higher pH level and calcium release describing that ultrasonic activation could promote a greater tubular penetration of the calcium hydroxide pastes. In accordance with the results mentioned previously, the present study showed that the ultrasonic activation also favored a greater dentinal sealer penetration and improved the interfacial adaptation between the sealer and the root canal walls, which can promote a higher contact and confinement of microorganisms present in the dentinal tubules (22).