Efficacy of Reciprocating Instruments for Removing Filling Material in Curved Canals Obturated with a Single-cone Technique: A Micro–computed Tomographic Analysis

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Abstract

Introduction: The aim of this study was to evaluate the efficacy of nickel-titanium reciprocating instrument techniques and passive ultrasonic irrigation (PUI) for retreatment in curved canals and obturated with correspondent single cones. **Methods:** Twenty molars were selected with mesial-buccal canals with curvatures between 20° and 40°, and they were instrumented with a Reciproc R25 instrument (VDW, Munich, Germany) in a reciprocating motion and obturated with single cones and AH Plus sealer (Dentsply Maillefer, Ballaigues, Switzerland). The teeth were divided into 2 groups (n = 10) according to the instrument used for the removal of filling material: group 1: Reciproc R25 instrument and group 2: WaveOne Primary instrument (Dentsply Maillefer). The analysis of the remnant filling material was made through micro–computed tomographic imaging after the use of reciprocating instruments and again after the use of PUI with xylene. The effective time of retreatment was registered. **Results:** The filling material of the root canal was efficiently removed (P < .05) for both groups. The percentage of removal of filling materials was 93% for the Reciproc group and 92% for the WaveOne group. There were no statistical significant differences (P > .05) between the groups in relation to the removal of filling material ability and the time needed for the procedure. The effective time for the removal of filling material was 78.7 seconds and 89.5 seconds for the Reciproc and WaveOne groups, respectively. **Conclusions:** It was concluded that both instruments efficiently but not completely removed the filling material from inside the root canals. The use of xylene with PUI increased the removal of filling material a little, but it was not statically significant. *(J Endod 2014;40:1000–1004)*

Key Words

Micro–computed tomography, reciprocating motion, root canal retreatment

Endodontic retreatments are a challenge with a high level of difficulty, and they are time-consuming (1). It has been considered that the use of rotary instruments could reduce the fatigue and time of endodontic retreatments (2). Furthermore, the use of balanced forces, such as those proposed by Roane et al in 1985 (3), allows one to maintain the original canal shape in curved root canals. Yared (4) introduced the reciprocating motion with new nickel-titanium (NiTi) instruments based on this concept of balanced forces, and it was shown to be effective in the preparation of the root canal using 1 instrument. Reciprocating motion is similar to the balanced forces because their counterclockwise angle was greater than the clockwise movement and led the file to continuously move toward the apex (5). Furthermore, the M-wire alloy increases the resistance and flexibility of the reciprocating instruments (6). This same technique is also used to remove filling material from the root canals in a brushing motion. In the literature, just 1 study analyzed these new NiTi reciprocating instruments in root canal retreatment on teeth with straight roots (7). There are few studies about the efficacy of filling material removal with NiTi rotary instruments in curved canals, mainly for resin sealers, which are the most used sealers nowadays, and for the removal of filling material in curved canals with reciprocating instruments (2, 8, 9).

Other studies used an invasive and destructive methodology to analyze the remnant filling material, and they were analyzed through 2-dimensional images (2, 5, 7). Micro–computed tomographic (micro-CT) imaging offers a noninvasive and reproducible technique for 3-dimensional (3D) evaluation of debris left inside root canals (10). The aim of this study was to compare, through micro-CT imaging, the remaining filling material after instrumentation using reciprocating files and again after passive ultrasonic irrigation (PUI) with xylene.

Materials and Methods

After ethics committee approval (protocol 2012/0122), 45 human upper molars from a total of 80 molars with curved mesial-buccal canals donated by São Leopoldo Mandic School of Dentistry, Campinas, São Paulo, Brazil, were selected. The crowns were flattened to a 16-mm length with a diamond disc (FKG, Dentaire,

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TABLE 1. Median, Minimum, and Maximum Values of the Volume (mm^3) of the Initial Filling Material (IM) after the Removal of Filling Material (R) and after PUI of the Studied Groups in the Different Levels and Total Length of the Root Canal

	Reciproc			WaveOne		
	IM	R	PUI	IM	R	PUI
Apical	0.422[a] (0.086–0.741)	0.015[b] (0–0.402)	0.008[b] (0–0.321)	0.445[a] (0.251–0.685)	0.015[b] (0.001–0.292)	0.015[b] (0.001–0.153)
Middle	1.095[a] (0.624–1.501)	0.048[b] (0–0.275)	0.029[b] (0–0.195)	1.039[a] (0.872–1.666)	0.081[b] (0.000–0.159)	0.081[b] (0.000–0.156)
Cervical	1.520[a] (1.024–2.381)	0.094[b] (0.003–0.232)	0.084[b] (0.003–0.219)	1.605[a] (1.034–1.985)	0.140[b] (0.000–0.338)	0.074[b] (0.000–0.304)
Total	3.162[a] (1.775–4.623)	0.244[b] (0.045–0.787)	0.207[b] (0.048–0.590)	3.073[a] (2.685–3.738)	0.243[b] (0.016–0.631)	0.203[b] (0.016–0.452)

PUI, passive ultrasonic irrigation.

Different letters indicate the statistically significance differences ($P < .05$) between each intragroup procedure.

Switzerland) initially established with a digital caliper. Next, they had the patency confirmed with a #15 K-file (Dentsply Maillefer, Ballaigues, Switzerland) under 8× magnification with an operative microscope (Alliance, São Paulo, Brazil). The real length of the teeth was observed by the tip of the file in the apex, and the working length was established 1 mm shorter. They were instrumented with R25 Reciproc files (VDW, Munich, Germany) in the respective Reciproc program of the VDW Silver Reciproc electric motor. The file was introduced until resistance was felt and used with 3 in-and-out pecking motions with light apical pressure. After that, the instrument was removed and cleaned. The canals were instrumented with 2.5% sodium hypochlorite and irrigated with 2 mL of this same solution each time after the 3 pecking motions until reaching the working length. The final irrigation was performed with 1 mL 17% EDTA for 1 minute and a final rinse with 2 mL 2.5% sodium hypochlorite with a 30-G NaviTip needle (Ultradent Products Inc, South Jordan, UT) (11). Next, they were dried with R25 paper points and obturated with R25 single cones (VDW) and AH Plus sealer (Dentsply Maillefer). The sealer was put in the cone tip and inserted into the canal in a single movement, and then the exceeded part of the cone in the coronal section was cut with a Touch'n Heat instrument (SybronEndo, Orange, CA). The crowns were sealed with Citodur (Dorident, Wien, Austria) temporary restorative material and stored at 37°C and 100% humidity for 3 months.

The teeth were digitally radiographed with sensor number 1 of the Schick CDR X-ray digital system (Schick Technologies, Long Island, NY) with 0.16 seconds of exposition time in the buccolingual and mesial-distal directions. The digital radiographs were evaluated regarding the quality of obturation, and 20 teeth with curvature angles between 23.2° and 39.89° were evaluated according to the Schneider method (12). The teeth were selected and divided into 2 groups with similar characteristics to ensure the homogeneity between the groups. In the WaveOne group ($n = 10$), the filing material was removed with the Primary WaveOne files (Dentsply Maillefer), and in the Reciproc group ($n = 10$), the filling material was removed with the R25 Reciproc files. An electric motor VDW Silver Reciproc with the respective programs for each file, Reciproc or WaveOne, was used with the same protocol of the initial instrumentation and irrigation. After reaching the working length, a brushing motion of the instrument was used until the complete removal of the filling material. The complete removal of the filling material was determined through the appearance of smooth walls and when the remaining filling material was not observed on the file and the presence of gutta-percha was not visible on the canal walls with a clinical microscope under 8× magnification (13). The same protocol of the irrigation with 2 mL 2.5% sodium hypochlorite each time after 3 pecking motions until reaching the working length was performed. One drop (0.8 mL) of xylene solvent was put in the pulp chamber for 1 minute before starting the first penetration of the instrument with the objective to facilitate the penetration into the canal to the medium third. The xylene solvent was not used in the latter steps of the instrumentation. Both in the initial instrumentation and in the filling material removal, just 1 file was used for each canal and then discarded. The effective time of desobturation was recorded. The effective time is only the time of action of the instrument inside the canal.

The teeth were mounted on a custom attachment and scanned in a micro-CT system (SkyScan 1174; Bruker-microCT, Kontich, Belgium). The 50-kv, 800-μA, and 30-μm voxel parameters were used before and after desobturation with the same protocols. Another scan was made after PUI with 1 drop (0.8 mL) of xylene solvent with an Irrisonic tip (Helse, São Paulo, SP, Brazil) driven by an ultrasonic device (Jet Sonic; Gnatus, SP, Brazil) with 20% of the power scale according to the manufacturer's instructions. It was applied for 20 seconds, 1 mm from the working length, and repeated 3 times. A final irrigation was made with 2 mL 2.5% sodium hypochlorite with a 30-G NaviTip needle. The samples were reconstructed with NRecon software version 1.6.3 (Bruker-microCT, Kontich, Belgium), and the axial cross-sections were obtained. Volumetric analyses of the 3D models were made with similar parameters with CTAn v.1.12 software (Bruker-microCT). The mean length of the canals measured through micro-CT imaging was 9.81 mm. Three segments of 3 mm, which we named the apical, middle, and cervical, were studied. The filling material volume was calculated from the binarized area inside the region of interest with the same parameters. The volumes were recorded and converted into percentages relative to the initial volume of the filling material.

TABLE 2. Median, Minimum, and Maximum Values of the Volume in Percentage (%) of the Filling Material Removal and after PUI in the Studied Groups in the Different Levels and Total Length of the Root Canal

	Reciproc		WaveOne	
	R	PUI	R	PUI
Apical	97[b] (44–100)	98[b] (55–100)	97[b] (53–100)	97[b] (58–100)
Middle	96[b] (77–100)	97[b] (84–100)	92[b] (84–100)	92[b] (89–100)
Cervical	94[b] (78–100)	94[b] (82–100)	91[b] (82–100)	95[b] (84–100)
Total	93[b] (77–98)	93[b] (83–98)	92[b] (83–99)	93[b] (89–99)

PUI, passive ultrasonic irrigation.

The same superscript letters in each row indicate no statistically significant differences ($P > .05$).