Efficacy of 2 Reciprocating Systems Compared with a Rotary Retreatment System for Gutta-percha Removal

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Abstract

Introduction: The maximum removal of root canal filling material is essential for successful endodontic retreatment. The purpose of this study was to assess the efficacy of 2 reciprocating systems (Reciproc [VDW, Munich, Germany] and WaveOne [Dentsply Maillefer, Ballaigues, Switzerland]) compared with a nickel-titanium (NiTi) rotary system (ProTaper Universal Retreatment [Dentsply Maillefer]) in the removal of root canal filling material. **Methods:** Sixty root canals of extracted human maxillary incisors were prepared using the NiTi ProTaper rotary system with the complementary use of a #40 K-type file and then obturated. The specimens were divided into 3 groups ($n = 20$) according to the system used for filling removal: group 1: instrument R25 of the Reciproc system, group 2: primary instrument of the WaveOne system, and group 3: NiTi rotary instruments of the ProTaper Universal Retreatment system. The teeth were cleaved longitudinally and photographed under a dental operating microscope with 5 × magnification. Images were transferred to a computer, and residual filling material was quantified using Image Tool software (University of Texas Health Science Center, San Antonio, TX). Results were compared using 1-way analysis of variance ($P < .05$). **Results:** All teeth examined had filling remnants within the canal. No statistically significant difference ($P > .05$) in residual filling material was observed among the groups, with 4.30% in group 1, 2.98% in group 2, and 3.14% in group 3. **Conclusions:** The Reciproc and WaveOne reciprocating systems were as effective as the ProTaper Universal retreatment system for gutta-percha and sealer removal. *(J Endod 2014;40:543–546)*

Key Words

Gutta-percha, nickel-titanium files, root canal retreatment, reciprocating motion

Nonsurgical retreatment is indicated in cases of failed endodontic treatment (1, 2). The effective removal of filling material from the root canal system is essential to ensure a successful outcome of the retreatment procedure (3–5).

Several methods have been used to remove root canal filling material, including the use of rotary systems specifically developed for this purpose. One of these systems is the ProTaper Universal retreatment system (Dentsply Maillefer, Ballaigues, Switzerland) (3, 6, 7). This system consists of 3 instruments: D1 (30/.09), D2 (25/.08), and D3 (20/.07) (8).

Recently, a new reciprocating motion approach (9) was introduced for instrumentation using nickel-titanium instruments with M-Wire alloy, which is considered more resistant than conventional alloys (10). Two systems, Reciproc (VDW, Munich, Germany) and WaveOne (Dentsply Maillefer), are based on this motion.

The Reciproc system consists of 3 single-use files: R25 (25/.08 in the first millimeters), R40 (40/.06 in the first millimeters), and R50 (50/.05 in the first millimeters). The WaveOne system consists of 3 single-use files: small (21/.06), primary (25/.08 in the first millimeters), and large (40/.08 in the first millimeters).

Few studies (11) have investigated the use of these 2 systems for the removal of filling material. The purpose of this study was to compare the efficacy of the WaveOne, Reciproc, and ProTaper Universal Retreatment systems in removing root canal filling material from straight canals of extracted human maxillary incisors.

Materials and Methods

Specimen Preparation

All the specimens used in this study were obtained from the tooth bank of the Dental Research Center, São Leopoldo Mandic University, Campinas, São Paulo, Brazil. The study protocol was reviewed and approved by the Research Ethics Committee of the same institution (protocol no. 2012/0124).

Sixty human extracted maxillary incisors with fully formed roots, single straight canals, patency, and no calcification, as confirmed radiographically, were selected for this study. The selected teeth were stored in a 0.1% thymol solution (Fórmula e Ação, São Paulo, SP, Brazil) until use.

The crowns were removed with a diamond disc (Brasseler USA, Savannah, GA) to leave a uniform root length of 16 mm. After this procedure and locating the canal orifice, a #10 K-type file was introduced into the canal until visible at the apical foramen with the aid of a dental operating microscope (DOM; Opto DM Plus, Opto, São Carlos,

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SP, Brazil) under 12.5 × magnification. The working length was determined by subtracting 1 mm from this measurement.

Root Canal Treatment

A single operator instrumented all the root canals using the NiTi ProTaper Rotary system (Dentsply Maillefer). The cervical and middle thirds of the canals were flared using the ProTaper SX and S1 rotary instruments and sizes 2, 3, and 4 Gates-Glidden drills (Dentsply Maillefer) in decreasing order.

The middle and apical thirds were instrumented with files S1 and S2 until encountering slight resistance, and the canals were then finished using instruments F1, F2, F3, and F4 until the working length was reached; this was complemented with a #40 K-type hand file (Dentsply Maillefer). At each instrument change, canals were irrigated with a 2.5% sodium hypochlorite (NaOCl) solution (Fórmula & Ação Farmácia) using a total of 25 mL per specimen. After completion of root canal instrumentation, 5 mL 17% EDTA (Fórmula & Ação Farmácia) was applied for 3 minutes to remove the smear layer, and canals were irrigated again with 5 mL 2.5% NaOCl solution.

The canals were dried with paper points and then filled with gutta-percha M cones (Dentsply Maillefer) and AH Plus Sealer (Dentsply DeTrey, Konstanz, Germany) by the continuous wave of condensation technique using the Touch'n Heat device (SybronEndo, Orange, CA). The gutta-percha cones were previously calibrated with a calibrating ruler (Dentsply Maillefer). In a second stage, the middle and cervical thirds of the canals were filled with Obtura II (SybronEndo). Buccolingual and mesiodistal radiographs were taken, allowing examination of the quality of the fillings with a digital CDR Elite Sensor (Schick Technologies, Long Island City, NY). Samples showing any voids within the filling were discarded. The coronal access cavities were sealed using a temporary filling material (Cavit-G; 3M ESPE, Seefeld, Germany). All specimens were kept at 37°C and 100% humidity for 30 days to allow full setting of the sealer.

Retreatment Technique

The 60 teeth were randomly divided into 3 groups with 20 specimens assigned to each group using a computerized algorithm (http://www.random.org). The groups represented the 3 different filling material removal systems to be applied, namely Reciproc system (VDW), WaveOne system (Dentsply Maillefer), and ProTaper Universal Retreatment system (Dentsply Maillefer).

In group 1, the R25 instrument of the Reciproc system was used with the VDW Silver motor (VDW) in an in-and-out pecking motion in the "RECIPROC ALL" mode until reaching the working length. In group 2, the primary instrument of the WaveOne system was used with the VDW Silver motor in an in-and-out pecking motion in the "WAVEONE ALL" mode until reaching the working length. The D1, D2, and D3 files of the ProTaper Universal Retreatment system were used sequentially in a pecking motion toward the apex until reaching the working length with D3 for group 3. All instruments were used with the VDW Silver motor at a constant speed of 500 rpm for D1 and of 400 rpm for both D2 and D3 with a torque of 3 Ncm.

A single operator performed all filling removal protocols. The rotary instruments were used for 5 canals and then discarded. The reciprocating instruments were used only once for each tooth according to the manufacturer's recommendation.

Irrigation during filling removal was performed using a total of 25 mL 2.5% NaOCl solution per tooth. Irrigation with 5 mL 17% EDTA for 3 minutes was performed to remove the smear layer in each tooth followed by final irrigation with 5 mL 2.5% NaOCl for each specimen.

The filling removal procedure was deemed complete when no further filling material was evident adhering to the instrument or to canal walls, which was checked with the aid of a DOM under 12.5 × magnification. No instrument fractures occurred during filling material removal.

Filling Removal Evaluation

A groove was made on the buccal and lingual aspects of the teeth with a diamond disc (Brasseler USA), and the teeth were cleaved with the aid of a no. 5 Le Cron spatula. Both root halves were photographed using a digital camera (Sony PC120; Sony Corporation, Tokyo) coupled to a DOM under 5 × magnification. Assessment of the residual filling material was performed by transferring the images to specific imaging software (Image Tool for Windows v.3.00; University of Texas Health Science Center, San Antonio, TX) used to measure the areas of remaining filling material and root canal periphery. The areas of filling remnants were delimited, computed, and expressed in square pixels. Mean percentage values were then calculated and compared.

Statistical Analysis

The mean percentage area of residual filling material was analyzed using 1-way analysis of variance. Calculations were performed by the SAS system (SAS system, release 9.2; SAS Institute Inc, Cary, NC).

Results

All teeth examined exhibited some residual filling material within the canals. The mean residual gutta-percha and sealer was 4.30% in group 1, 2.98% in group 2, and 3.14% in group 3 (Table 1). No statistically significant difference ($P > .05$) was observed among the groups.

Discussion

The success of endodontic retreatment directly hinges on the maximum removal of filling material (12, 13) in that poorly instrumented and obturated root canal systems can lead to the harboring of necrotic tissues and microorganisms responsible for endodontic treatment failure (1, 7). Although root canal anatomy varies widely, human single-rooted teeth were used in this study because of their ease of handling and simulation of treatment to reflect real endodontic practice as closely as possible. The removal of tooth crowns was a means of standardizing the working length and the approximate amount of filling material across the samples. It was also intended to rule out the influence of certain variables such as the anatomy of the tooth crown and access to the root canal, thus resulting in a more reliable study (3, 6, 7, 14–17).

After obturation, the specimens were stored at 37°C and 100% humidity for 1 month to ensure the sealer was fully set (7, 12,18–20). Filling removal was deemed complete when no further filling material was evident adhering to the instrument or to canal walls. The absence of residual material was checked using a dental operating

TABLE 1. Means and Standard Deviations of Residual Filling Material (expressed as percentage area) on Canal Walls after Application of the Studied Filling Material Removal Methods

Groups	*n*	Mean (standard deviation)
Reciproc	20	4.30 (2.56)*
WaveOne	20	2.98 (1.87)*
ProTaper Universal Retreatment	20	3.14 (1.71)*

*Nonsignificant difference at the 5% level.

microscope under 12.5 × magnification in line with studies validating the importance of operating microscopes in endodontic retreatment (13, 21).

In the present study, the amount of residual filling material was assessed by sectioning the roots longitudinally into separate halves (6, 16, 22). The cleaving method must be performed carefully so as not to dislodge the gutta-percha, which is why the roots were first grooved with a diamond disc and then cleaved using a spatula (7). In addition, radiographic analysis only produces a 2-dimensional image and has proven less effective than the cleaving method.

Various different retreatment techniques have been proposed, including hand files (19, 22, 23) and rotary instruments (7, 16, 17). Conventional removal of gutta-percha by way of hand files, with or without solvent, can be painstaking and time-consuming, particularly when the filling material is highly condensed (6). Solvents such as chloroform have been use to facilitate the process, but these should be used with care given their cytotoxic potential and potential for forming a residual film of softened gutta-percha on the dentin walls (3, 24). In this study, ProTaper Universal Retreatment rotary instruments and Reciproc and WaveOne reciprocating instruments were used without the use of solvents.

ProTaper Universal Retreatment instruments were used at a constant speed of 500 rpm for D1 and at 400 rpm for D2 and D3 with a torque of 3 Ncm. The speed and torque were established by previous analyses and followed manufacturer's recommendations. The favorable results observed in this study for the ProTaper Universal Retreatment system are in agreement with the findings of Takahashi et al (7) and Giuliani et al (16). The rotary instruments convey debris toward the cervical portion of the canal because of their cross-sectional shape (25). According to Hülsmann and Bluhm (26) and Giuliani et al (16), the ProTaper Universal Retreatment system is able to remove large amounts of gutta-percha through spirals running around the instruments, which produce both cutting and softening actions. The negative cutting angle and the absence of radial land exert a cutting action as opposed to a planing action on the gutta-percha (16).

Because the aim of this study was to compare the efficacy of the techniques for the removal of gutta-percha and sealer up to the working length, the canals were not reinstrumented in accordance with the studies by Takahashi et al (7) and Bramante et al (27). Thus, the presence of filling material in the apical third was expected.

The D3 (tip size 20) of the ProTaper Universal Retreatment system is the final instrument recommended by the manufacturer, whereas the R25 (tip size 25) of the Reciproc and the primary (tip size 25) of the WaveOne systems were elected for being the reciprocating instruments whose tips are the closest equivalent to the tip of the D3 instrument. To achieve enhanced cleansing, reinstrumentation up to the working length using larger size instruments than those used during initial treatment is required (27).

The results of the present study revealed that none of the canals submitted to filling removal were completely devoid of residual gutta-percha and sealer. This finding is consistent with those of Bramante et al (27) and Xu et al (28), who reported the virtual impossibility of removing 100% of the residual gutta-percha and sealer from root canal walls, irrespective of the technique used for filling material removal.

Although the Reciproc and WaveOne reciprocating systems were not originally designed for retreatment, the hypothesis that the special design of their instruments as well as the reciprocating motion can be potentially beneficial for the effective removal of filling material was confirmed in this study given that there was no statistical difference between the ProTaper Universal Retreatment system, which was devised specifically for retreatment, and the Reciproc and WaveOne reciprocating systems. The favorable results observed for the Reciproc system corroborated those reported in the study by Zuolo et al (11) in which the Reciproc R50 showed the best results; the results were comparable with those of hand files combined with Gates-Glidden drills. In a review of the literature, we found no reports on the use of the WaveOne reciprocating system for the removal of gutta-percha and sealer.

Reciprocating systems produce a broader motion in the counterclockwise direction yet shorter in the clockwise direction, keeping the file more centered in the canal (10, 29). This factor, together with the marked taper of these files, creates a greater contact area between the instrument and gutta-percha, allowing filling removal that is as effective as that produced with continuous rotation.

Clinicians are concerned not only about the ability to remove filling material effectively but also the level of safety provided by endodontic instruments during the removal procedure. Beasley et al (30) reported fractures and deformations in some D3 files of the ProTaper Universal Retreatment System during filling removal in moderately curved canals. The authors attributed these drawbacks to the high taper of the instrument and to the speed applied during its use, factors which could have led to an increase in the torsional fatigue of the instrument in contact with the filling materials studied. In our study, no instrument fracture was observed during the root canal filling removal procedure. This could be related to the more favorable anatomy of the canals used in our study (ie, without curvatures). For the Reciproc and WaveOne systems, factors such as more favorable anatomy, good resistance to torsional and cyclic fatigue (31) promoted by the reciprocating motion, and the M-wire alloy used in the composition of the instruments may also have contributed to the lack of fractures and deformations. Further studies comparing rotary and reciprocating retreatment systems, especially regarding the occurrence of fractures, deformations, and other procedural mishaps, are warranted, particularly in curved canals.

In conclusion, the Reciproc and WaveOne reciprocating systems were as effective as the ProTaper Universal Rotary Retreatment system for the removal of gutta-percha and sealer from the root canal of extracted human maxillary incisors.

Acknowledgments

The authors deny any conflicts of interest related to this study.

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