Efficacy of ProTaper Universal Retreatment Files in Removing Filling Materials during Root Canal Retreatment

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Abstract

The aim of this study was to evaluate the efficacy of the ProTaper Universal System rotary retreatment system and of Profile 0.06 and hand instruments (K-file) in the removal of root filling materials. Forty-two extracted single-rooted anterior teeth were selected. The root canals were enlarged with nickel-titanium (NiTi) rotary files, filled with gutta-percha and sealer, and randomly divided into 3 experimental groups. The filling materials were removed with solvent in conjunction with one of the following devices and techniques: the ProTaper Universal System for retreatment, ProFile 0.06, and hand instruments (K-file). The roots were longitudinally sectioned, and the image of the root surface was photographed. The images were captured in JPEG format; the areas of the remaining filling materials and the time required for removing the gutta-percha and sealer were calculated by using the nonparametric one-way Kruskal-Wallis test and Tukey-Kramer tests, respectively. The group that showed better results for removing filling materials was the ProTaper Universal System for retreatment files, whereas the group of ProFile rotary instruments yielded better root canal cleanliness than the hand instruments, even though there was no statistically significant difference. The ProTaper Universal System for retreatment and ProFile rotary instruments worked significantly faster than the K-file. The ProTaper Universal System for retreatment files left cleaner root canal walls than the K-file hand instruments and the ProFile Rotary instruments, although none of the devices used guaranteed complete removal of the filling materials. The rotary NiTi system proved to be faster than hand instruments in removing root filling materials. *(J Endod 2008;34:1381–1384)*

Key Words

Gutta-percha removal, ProTaper Universal, root canal retreatment, rotary NiTi instruments

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Endodontic failure might occur in case of persistence of bacteria in the root canal system as a consequence of insufficient cleaning, inadequate obturation, or when there is coronal leakage (1). The failure might be successfully remedied by orthograde retreatment or, if that is not possible, by a surgical procedure (2).

Nonsurgical procedures require the complete removal of filling materials from the endodontic space to obtain 3-dimensional cleaning, shaping, and obturation of the root canal system (3).

Many techniques with rotary nickel-titanium (NiTi) instruments (4–7), ultrasonic instruments (8–10), heat pluggers (11, 12), and manual instruments with chemical solvents (chloroform, eucalyptol, orange oil) have been proposed for removing root filling materials (13–15). Rotary Ni-Ti instruments proved to be effective (4, 5, 16) and time-saving (4, 17, 18) in removing filling materials. However, none of the several treatment alternatives seems to guarantee canal walls that are completely free of debris (4, 13, 17).

Progressively tapered Ni-Ti rotary files, ProTaper, were developed in 2001. ProTaper instruments (Dentsply Maillefer, Ballaigues, Swizerland) have a convex triangular cross-sectional design with different shafts (19).

Recently, a new NiTi rotary system, ProTaper Universal Tulsa (Dentsply Tulsa, Tulsa, OK) was introduced (20). With respect to the original kit, the new system was integrated with 3 new ProTaper retreatment files, D1, D2, D3, two new ProTaper finishing files, F4 and F5, and with the ProTaper obturator and gutta-percha points.

The 3 ProTaper Universal System retreatment files (PTUS) are designed to facilitate the removal of filling material. Each file has different lengths, tapers, and apical tip diameters. The D1 PTUS instrument has an active tip to facilitate initial penetration into the filling material; the D1 instrument has a length of 16 mm, a tip of 0.30 mm, and a 0.09% taper. The D2 PTUS instrument for removal of filling material at the level of the middle third of the root has a length of 18 mm, a tip of 0.25 mm, and a 0.08% taper. The D3 PTUS instrument for apical filling removal with a length of 22 mm, a tip of 0.20 mm, and a 0.07% taper is used to reach the working length.

According to our knowledge, the literature to date contains only a few studies investigating the use of PTUS retreatment files (21, 22).

The purpose of the study was to compare the cleanliness of root canal walls after retreatment with ProFile rotary Ni-Ti instruments (Dentsply Maillefer), PTUS retreatment files, and Hedström files in single-rooted human teeth.

Materials and Methods

Forty-two extracted single-rooted anterior teeth were selected. The teeth were cleaned with an ultrasonic scaler and washed with sterile solution. Preoperative mesiodistal and buccolingual radiographs were taken to verify the presence of a single straight canal. The coronal access cavity was opened by using a high-speed carbide bur and water spray. After removal of the pulp tissue, patency was assured with a size 10 K-file (Dentsply Maillefer), and the working length was defined at the apical foramen. To standardize the samples, the tooth crowns were cut to obtain root canals with a working length of 19 mm.

Canal Preparation

All the samples were prepared by a single operator. The root canal was enlarged by using a crown-down technique. ProFile 0.06 Taper instruments (Dentsply Maillefer)

TABLE 1. Remaining Filling Material in the Whole Root Canal (expressed as percentage area) for Each Group

Technique	N	Mean (standard deviation)
ProFile	14	10.19 (2.3)
ProTaper	14	5.20 (2.66)
Manual	14	11.72 (5.01)

were used in a variable tip sequence from 40–30 until the canal was prepared for instrument size 06/30 at the working length. An electric motor powered at 250 rpm and in a 1:16 ratio (Tecnica/ATR Motor, Pistoia, Italy) was used for all NiTi instruments. Copious irrigation with sodium hypochlorite 5% (Niclor 5; OGNA, Milan, Italy) was used during the shaping. A final rinse with 10% ethylenediaminetetraacetic acid (Tuboliclean; OGNA) for 2 minutes followed by a rinse with sterile water completed the preparation.

Canal Obturation

The root canal was dried with sterile paper points and obturated with gutta-percha and sealer (Pulp Canal Sealer; Kerr, Romulus, MI) by using continuous wave of warm gutta-percha technique. Back-filling was performed by using thermoplasticized gutta-percha applied with an Obtura II (Obtura Corp, Fenton, MO). The access cavity was restored by using the resin bonding technique.

The quality of the root filling was deemed adequate when no voids could be seen on the mesiodistal and buccolingual radiographs. All the teeth were stored at 37°C in 100% humidity environment for 2 weeks to allow complete setting of the sealer.

Retreatment Technique

The teeth were randomly divided into 3 groups of 14 each. The coronal filling was removed to allow access to the entrance of the canal. A drop of solvent (Endosolv E Septodont of Canada, INC, Cambridge, ON, Canada) was placed in the chamber to soften the gutta-percha; a total of 0.5 mL of solvent was used during the retreatment procedure for each tooth. A low-torque control motor (Tecnica/ATR Motor) in the preset torque levels recommended by the manufacturer for each type of instrument was used in the following 3 experimental groups.

In group A, ProFile System sizes 40/06 30/06 (Dentsply Maillefer) were used in a crown-down technique to remove gutta-percha and sealer. The canals were reinstrumented with ProFile sizes 06/40 and 06/35 in the crown-down manner. The final apical diameter of each root canal was 35 mm.

In group B, PTUS instruments D1, D2, and D3 were used for retreatment in the crown-down technique until D3 reached the working length. Each sample was reprepared with ProTaper Universal Rotary Shaping (S1, S2) and Finishing files (F1, F2, F3) according to the manufacturer's instructions, until F3 reached the working length. The final apical diameter of each root canal was 0.30 mm.

In group C, gutta-percha and sealer were removed by using Hedström file (Dentsply Maillefer) in a crown-down technique. The re-preparation was done by hand with stainless steel K-files (Dentsply Maillefer), with enlargement to size 35 and step-back increments to size 50.

A total volume of 20 mL of 5% sodium hypochlorite was used as an irrigant for each tooth during the canal re-preparation. Each instrument was discarded after use in 5 canals, and a single operator prepared all the samples.

Removal of filling materials was judged complete when the working length was reached, and no more gutta-percha could be seen on the last instrument used; the time in seconds was recorded. All the teeth were grooved buccolingually with a diamond disk and sectioned longitudinally. Both halves of the root canal were photographed (Nikon Coolpix 4500; Nikon, Melville, NY) under a stereomicroscope at 40× magnification. The photographs of the samples obtained were captured as JPEG images. The remaining gutta-percha and sealer on the split root halves were measured by the Image J 1.33u Program (National Institutes of Health, Bethesda, MD). The evaluation of coded specimens was performed by 2 operators blinded to the techniques and the devices used for retreatment. For each specimen, the arithmetical means of the area of the canal and of remaining gutta-percha and sealer (in millimeters), obtained by the 2 operators, were used to measure the percentage of remaining filling materials for all specimens.

Statistical Analysis

The intraclass correlation coefficient (ρ) was calculated to estimate the reliability of the measurements taken by the 2 examiners. The percentage of remaining filling material and the mean time of gutta-percha removal were evaluated for each group. Descriptive statistics were expressed by means and standard deviations. The one-way analysis of variance test, post hoc Tukey-Kramer honestly significant difference test, and 95% confidence intervals were used to identify differences between the groups at the apical, middle, and coronal levels. The significance level was set at $P < .05$.

Results

The value of the intraclass correlation coefficient was very high ($\rho = 0.99$). Means and standard deviations of the percentage of residual filling materials are reported in Table 1. When the percentage of residual filling materials (gutta-percha and sealer) was analyzed in the whole root canal retreatment, there was a statistically significant difference between the PTUS and Profile techniques ($P < .005$). Group B (5.20 ± 2.66) obtained better results than groups A (10.19 ± 2.30) and C (11.72 ± 5.01). No statistically significant difference was found between groups A and C (Table 1).

The descriptive analysis regarding the differences among the 3 techniques in the apical, middle, and coronal portions of the root are presented in Table 2.

In the coronal and middle third of the retreatment technique, group B obtained better results than groups A and C ($P < .005$). At the same levels, in group A significantly less filling material was observed than in group C ($P < .005$).

In the apical portions, significant differences in the cleanliness of the roots were observed between groups B and C ($P < .005$); no significant difference was observed between groups A or B and between groups A and C.

TABLE 2. Comparison between the 3 Experimental Groups for the Remaining Filling Materials

	n	Group A, Mean (standard deviation)	Group B, Mean (standard deviation)	Group C, Mean (standard deviation)
Coronal portion	14	3.00 (1.96)	1.08 (1.23)	3.00 (1.73)
Middle portion	14	3.76 (1.27)	2.22 (1.26)	4.18 (2.01)
Apical portion	14	3.44 (1.74)	1.89 (1.40)	4.58 (2.73)

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