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Efficacy of ProTaper Retreatment System in Root Canals Filled with Gutta-Percha and Two Endodontic Sealers

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Abstract

This study evaluated the efficacy of ProTaper Universal rotary retreatment system and hand files for filling material removal during retreatment and the influence of sealer type on the presence of filling debris in the reinstrumented canals. The canals of 60 palatal roots of first molars were obturated with gutta-percha and either a zinc oxide–eugenol–based or a resin-based sealer and reinstrumented: G1, EndoFill/hand files; G2, AH Plus/hand files; G3, EndoFill/ProTaper; G4, AH Plus/ProTaper. Roots were cleaved and examined with an optical microscope, and the amount of filling debris on canal walls was analyzed on digitized images. There was no significant difference ($P > .05$) among the root canal thirds within each group. G3 presented significantly more filling debris than G1 in the cervical third ($P = .04$). In the middle third, G2/G3/G4 showed more debris than G1 ($P = .03$). The techniques were similar ($P = .64$) in the apical third. All groups presented filling debris in the 3 canal thirds after reinstrumentation.

Key Words: Endodontic retreatment; endodontics; root canal filling

Introduction:

When endodontic treatment fails, nonsurgical endodontic retreatment is often indicated as the first choice to eliminate or to substantially reduce the microbial load from the root canals. However, well-compacted filling material offers resistance to instruments, and incomplete removal of gutta-percha and sealer limits the access to the apical foramen and impairs root canal disinfection and reshaping. Several studies ([1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13] and [14]) have reported that debris is left on canal walls after root canal retreatment, regardless of the type of instrumentation (hand or rotary), type of filling material, and use or not of solvents.

Different rotary systems (Profile ([1], [2], [5], [6], [7] and [15]), Quantec (15), GT Rotary (3), K3 ([4], [6] and [12]), Protaper ([3], [6], [10], [11] and [12]), and RaCe (10)) have been evaluated for root filling removal and root canal reinstrumentation. More recently, ProTaper nickel-titanium (NiTi) rotary system has been upgraded to the ProTaper Universal rotary system, which offers, in addition to shaping and finishing instruments, retreatment files designed specifically to remove obturation material from root canals. To date, few data are available about the behavior of ProTaper Universal retreatment instruments in endodontic retreatment (16). Therefore, this in vitro study evaluated comparatively the efficacy of the ProTaper Universal (Tulsa Dental, Tulsa, OK) rotary retreatment system and hand files for removal of filling material during root canal retreatment and the influence of the type of sealer on the presence of filling debris in the reinstrumented canals.

Material and Methods

Specimen Selection

Sixty maxillary first molars were radiographed and selected if they had a palatal root with a single straight canal (or curvature <5 degrees) and fully formed apex. The apical 16 mm of the palatal roots was sectioned for use to standardize canal length in all teeth.

Initial Endodontic Treatment

The canals were prepared according to a crown-down technique with Flexofile hand files (21 mm, 1st/2nd series; Dentsply/Maillefer, Ballaigues, Switzerland). The cervical and middle thirds were preflared with Gates-Glidden drills sizes 2 and 3 (Dentsply/Maillefer). Briefly, each canal was negotiated with a size 15 file until its

tip was visible at the apical foramen, and the working length (WL) was established 1 mm short of canal length (15 mm). The apical stop was prepared with a size 30 file. Canals were irrigated with 1 mL 1% NaOCl at each change of file. When instrumentation was completed, the canals were filled with 17% ethylenediaminetetraacetic acid during a period of 3 minutes, flushed with 1% NaOCl, dried with absorbent paper points, and obturated with lateral compaction of thermoplasticized gutta-percha and either a zinc oxide–eugenol (ZOE)–based sealer (Endofill; Dentsply Ind e Com Ltda, Petrópolis, RJ, Brazil) or a resin-based sealer (AH Plus; Dentsply De Trey GmbH, Konstanz, Germany). Sealers were taken to the canals with the master gutta-percha cone, which was coated and inserted in a single movement. The quality and apical extent of root fillings were confirmed radiographically. The specimens used in this experiment had well-compacted fillings extending to 1 mm short of the apex. The access cavities were sealed (Coltosol; Coltene-Whaledent, Cuyahoga Falls, OH), and the roots were stored in artificial saliva at 37°C for 3 months.

Endodontic Retreatment

Thirty roots had their canals (15 filled with gutta-percha/Endofill [G1] and 15 with gutta-percha/AH Plus [G2]) emptied and reinstrumented with hand files. Gates-Glidden drills sizes 3 and 4 were first used at the cervical and middle thirds, and the filling mass was penetrated with a size 60 Hedström file (Dentsply/Maillefer) followed by sizes 55, 50, 45, and 40, until the WL was reached with a size 35 or 30 file. The apical third was enlarged up to a size 45 Flexofile hand file.

The other 30 roots had their canals (15 filled with gutta-percha/Endofill [G3] and 15 with gutta-percha/AH Plus [G4]) emptied with the ProTaper Universal NiTi rotary retreatment files and reinstrumented with ProTaper Universal NiTi rotary shaping and finishing instruments, following manufacturer's instructions. Root fillings were removed by using the D1, D2, and D3 retreatment files, which have a convex cross section with taper/tip diameter of 0.09/0.30, 0.08/0.25, and 0.07/0.20 mm, respectively. D1, D2, and D3 files were activated by an electric engine (Endo-Pró, Driller, São Paulo, SP, Brazil; 3 N/cm torque, 500 rpm speed) and used with a brushing action in a crown-down manner at the cervical, middle, and apical canal thirds, respectively, until reaching the WL. When 1 mm of filling material was left apically, the final canal portion was negotiated by using sizes 15 and 20 files with 1% NaOCl. Canal refinement was accomplished with the shaping (S1 and SX in the cervical third and S2 in the middle third) and finishing instruments (F1, F2, and F3 up to WL) at 2 N/cm torque and 250 rpm speed.

No solvent was applied so that the sealers did not have their removal affected by solvent use. For both techniques, the canals were irrigated with 1% NaOCl between files, filled with 17% ethylenediaminetetraacetic acid after reinstrumentation, and flushed again with 1% NaOCl.

Analysis of Filling Debris

The roots were grooved longitudinally in a buccolingual direction with a diamond disk and split into halves with a chisel. The root half with greater amount of filling debris on visual inspection was examined with an operative clinical microscope at ×10 magnification (DF Vasconcellos, São Paulo, SP, Brazil). Images were captured with a digital camera (Nikon-Colpix, Tokyo, Japan) coupled to the microscope and analyzed with AutoCAD 2004 software (Mechanical Desktop Power Pack; Microsoft, Redmond, WA). Canal walls and filling debris were identified on the basis of the difference of radiopacity. A single operator used a specific software tool to outline the canal area and the filling debris area in each third (cervical, middle, and apical), as well as the total canal area.

The filling debris area/canal area ratios were considered for statistical analysis and expressed as percentage of filling material left after reinstrumentation. Data were analyzed by Kruskal-Wallis test and Student-Newman-Keuls test for multiple comparisons at $P < .05$. First, statistics compared the canal thirds within each group; next, the groups were compared in each canal third; finally, intergroup comparison considered the total canal area to calculate the filling debris area/canal area ratios.

Results

Table 1 presents the filling debris area/canal area ratios obtained in the 3 canal thirds for the studied groups. Table 2 compares the groups regarding the filling debris area/canal area ratios in each canal third. G3 presented significantly more filling debris than G1 in the cervical third ($P = .04$). In the middle third, G2, G3, and G4 showed more debris than G1 ($P = .03$). The techniques did not differ significantly ($P = .64$) in the apical third. Filling debris area/canal area ratios for the total canal area in each group are presented in Table 3.

TABLE 1. Filling Debris Area/Canal Area Ratios (%) in the Cervical, Middle, and Apical Thirds for the Different Groups

	Cervical Third	Middle Third	Apical Third	*P* Value
G1	0.034322 (0.064183)	0.049115 (0.104533)	0.092614 (0.14312)	.05
G2	0.052692 (0.061595)	0.091637 (0.116722)	0.092614 (0.14312)	.63
G3	0.205882 (0.247242)	0.148637 (0.159277)	0.136439 (0.191388)	.79
G4	0.223936 (0.298752)	0.166132 (0.150775)	0.157621 (0.165576)	.95

Values expressed as means (standard deviations).
Statistically significant difference if $P < .05$ (Kruskal-Wallis test).

TABLE 2. Intergroup Comparison Regarding Filling Debris Area/Canal Area Ratios in Each Root Canal Third

Third	Group	*P* Value
Cervical	G3 > G1	.04
Middle	G2, G3, and G4 > G1	.03

Third	Group	*P* Value
Apical	G1 = G2 = G3 = G4	.64

 Statistically significant difference if *P*< .05 (Kruskal-Wallis test).

TABLE 3. Filling Debris Area/Canal Area Ratios (%) for the Total Canal Area in Each Experimental Group

G1	G2	G3	G4
0.048311[a]	0.078681[a,b]	0.157667[b]	0.160895[a,b]
(0.080741)	(0.0494)	(0.167058)	(0.155456)

Values expressed as means (standard deviations). Different superscript letters indicate statistically significant difference at 5% significance level (Kruskal-Wallis test).

Discussion

In endodontic retreatment, it is consensual that accurate removal of gutta-percha and sealer followed by adequate canal reinstrumentation provides better access to the necrotic tissue remnants and microorganisms causing persistence of periapical inflammation. However, previous studies have found that completely clean canal walls were not produced with any of the techniques investigated ([5], [7], [8] and [12]). Likewise, in the present study, filling debris was found in all cleaved canals after endodontic retreatment with both hand files and ProTaper Universal system. In the cervical third, significant differences were observed between hand and rotary instrumentation in canals filled with the ZOE-based sealer. Canals emptied and prepared with rotary instruments left more gutta-percha and Endofill debris than those reinstrumented with hand files (*P* = .04). The cervical third was the most critical for ProTaper retreatment. However, cleanliness in the cervical and middle thirds of G1 and G2 was more likely due to the action of the Gates-Glidden drills than the hand files because the kinematics of these drills pushes the filling material out of the root canal.

In the middle third, hand reinstrumentation of canals filled with Endofill left less filling debris than rotary instrumentation associated with Endofill or AH Plus and hand files associated with AH Plus (*P* = .03). In the same way as reported by Zmener et al. (7), more filling debris was left in the middle third of canals reinstrumented with rotary instruments. Kosti et al. (5) observed a greater amount of resin-based sealer (AH 26) in the middle third, although without significant difference between the rotary and hand techniques for this type of sealer. It might be speculated that because resin-based sealers have better adhesion to dentin walls, their removal from root canals with rotary instruments is more difficult. The manufacturer of the ProTaper Universal system contraindicates its use in root canals filled with these sealers, which might help explain the presence of more filling debris in G3/G4.

The apical root canal third is a critical area for cleaning, shaping, and filling procedures. In terms of case prognosis, the real impact of the presence of debris after filling material removal and reinstrumentation of infected canals remains

unclear. In the present study, regardless of the technique and sealer, this region of the canal presented filling material remnants, although without significant differences (*P* = .64) among the groups. Because G1/G2 were prepared to an apical diameter of around 0.45 mm and G3/G4 of around 0.30 mm, cleaner apical canal sections would be expected in both manually instrumented groups. However, it was not observed in the present study, perhaps because the great taper of the F3 instrument (taper 0.09) determines a diameter of 0.39 and 0.48 mm at 1 and 2 mm from its tip, respectively, approaching the diameter of size 45 hand files at these distances. It should also be considered that hand files can be precurved and directed to the regions in which the tactile sensation indicates the presence of filling material. Therefore, the combined use of hand and rotary instruments appears to be a good option to improve apical cleaning.

A previous ex vivo study (7) evaluating retreatment efficacy of hand versus automated instrumentation did not find differences between rotary/oscillatory instruments and hand files in the apical third. Masiero and Barletta (4) justified the fact that rotary instrumentation (K3 system) promoted better apical cleaning compared with other techniques because the shape of canals reinstrumented with the K3 system was similar to the original canal section. In the present study, rotary instrumentation was not more effective than hand files in the apical third, where the canal section tends to be circular.

Regarding the total canal area, differences between the techniques were observed only when the ZOE-based sealer was used; more filling debris was found when ProTaper Universal System was used (*P* = .002). Most studies did not detect differences between hand and rotary instrumentation with different sealers considering the total canal area ([11] and [12]), possibly as a result of nonuse of solvent. Although the findings of the present study are consistent, extrapolation to the clinical condition should be done with care. Further research is necessary for this system to be used in a safer and more effective manner for endodontic retreatment.

The following might be concluded (1). Debris was left in all canal thirds, regardless of the retreatment technique (2). The greatest differences between techniques and sealers were found in the middle third, with less amount of debris in canals obturated with Endofill and reinstrumented with hand files (3). The techniques had similar cleaning efficacy in the apical third, regardless of the sealer.

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