



Evaluation of Apically Extruded Debris from Curved Root Canal Filling Removal Using 5 Nickel-Titanium Systems

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Abstract

Introduction: This study evaluated the amount of apically extruded debris in the retreatment of curved root canals using different nickel-titanium (NiTi) systems: the ProTaper Universal Retreatment (Dentsply Maillefer, Ballaigues, Switzerland), Mtwo Retreatment (VDW, Munich, Germany), D-Race Retreatment (FKG Dentaire, La Chaux-de-Fonds, Switzerland), R-Endo Retreatment (Micro-Mega, Besançon, France), and Reciproc (VDW) systems. **Methods:** One hundred human mandibular premolars with curved root canals were prepared with the Reciproc #25 .08 NiTi system filled with AH Plus Jet (Dentsply DeTrey, Konstanz, Germany) sealer and gutta-percha and divided into 5 groups ($n = 20$). The canal filling was removed with the ProTaper, Mtwo, D-Race, and R-Endo retreatment systems and Reciproc instruments. Final preparation was done with the Reciproc #40 .06 NiTi system. Extruded debris was collected in preweighed Eppendorf tubes. The times required for retreatment were recorded. **Results:** Reciproc produced significantly ($P < .001$) more debris than the other systems. ProTaper R and Mtwo R produced significantly ($P < .001$) more debris than D-Race and R-Endo. The Reciproc group required significantly ($P < .001$) less preparation time than the other groups. **Conclusions:** In the retreatment of curved root canals, the Reciproc system extruded significantly more debris than the rotary retreatment NiTi systems. In addition, the ProTaper and Mtwo retreatment systems extruded significantly more debris than the R-Endo and D-Race systems. The Reciproc system was significantly faster than the rotary retreatment systems. (*J Endod* 2016;42:1101–1104)

Key Words

Apical extrusion, debris extrusion, endodontic retreatment, NiTi

Nonsurgical endodontic retreatment is recommended as the first choice when initial root canal therapy fails (1). During root canal retreatment, all preparation techniques and instruments are associated with the extrusion of debris, such as root filling materials, organic tissue remnants, bacteria, and irrigants (2, 3). Extruded debris may trigger an inflammatory reaction in the apical region and cause a flare-up or long-term failure (4). Moreover, a greater amount of extruded debris may result in a greater reaction (5, 6).

Several techniques and instruments can be used to remove root canal filling material, including nickel-titanium (NiTi) instruments (7), ultrasonic systems (8), laser systems (9), and chemical solvents (10). NiTi systems including the ProTaper Universal retreatment system (Dentsply Maillefer, Ballaigues, Switzerland), the Mtwo retreatment system (VDW, Munich, Germany), the D-Race retreatment system (FKG Dentaire, La Chaux-de-Fonds, Switzerland), the R-Endo retreatment system (Micro-Mega, Besançon, France), and the Reciproc (VDW) single-file NiTi reciprocating system can be used for the removal of gutta-percha.

The ProTaper Universal retreatment system has 3 files (D1–D3), which have convex, triangular cross sections. The D1 file has an active working tip that facilitates penetration into the filling material (11). The Mtwo retreatment system has 2 files with cutting tips at a constant helical angle (12). The D-Race retreatment system also has 2 files (DR1 and DR2) with alternating cutting edges and triangular cross sections. The DR1 instrument has an active working tip (13). The R-Endo retreatment system has a hand file and 4 NiTi files. The NiTi files have triangular cross sections with 3 equally spaced cutting edges and no radial land with inactive tips (14).

Several studies have evaluated the amount of apically extruded debris during retreatment procedures (5,15–17), and some have compared the effects of various retreatment systems (17–19). However, no study has quantified the amount of apically extruded debris during retreatment in curved root canals.

This study determined the weight of apically extruded debris in the retreatment procedure in curved root canals using the following NiTi systems: the ProTaper Universal retreatment, Mtwo retreatment, D-Race retreatment, R-Endo retreatment, and Reciproc systems.

Significance

In curved root canals, rotating NiTi systems with less taper designed for retreatment may cause less apical extrusion during the procedure. Also, The Reciproc system was significantly faster than the rotary retreatment systems in curved root canals.

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Materials and Methods

One hundred freshly extracted human mandibular premolars with a single root canal, mature apex, and a root canal curvature of 20°–40° were used (20). Radiographs were taken in the buccal and proximal directions to ensure that there was no internal resorption, root canal calcification, fracture, or crack. Soft tissue remnants and calculi on the external root surface were removed by hand and with ultrasonic devices.

To standardize the specimen length, all teeth were shortened to 20 mm by flattening the occlusal surface, and a coronal access cavity was opened using a high-speed bur. The working length (WL) of each canal was determined to be 1 mm short of the length of a size 10 K-file (Dentsply Maillefer) that was visible at the major diameter of the apical foramen.

All teeth were prepared with a Reciproc #25 .08 NiTi system to the WL using a reciprocating slow in-and-out pecking motion according to the manufacturer's recommendation. The apical canal patency was controlled with a size 10-K file.

During the instrumentation procedure, 5% sodium hypochlorite was used for irrigation. For the final irrigation, 5 mL 17% EDTA, 5 mL 5% sodium hypochlorite, and 10 mL distilled water were used.

The root canals were dried with paper points (VDW) and filled with AH Plus Jet (Dentsply DeTrey, Konstanz, Germany) and gutta-percha using a cold lateral condensation technique. The master cones were #25 .08 gutta-percha cones (VDW). The root canal fillings were removed coronally with a heated instrument and limited to 16 mm from the apex so that the volume of the gutta-percha filling was approximately equal in all teeth. After temporary restoration of the access cavities, the teeth were stored in an incubator at 37°C and 100% humidity for 8 weeks to allow complete setting of the sealer.

All teeth were placed in a vial system that had been preweighed 3 times using an analytical balance (AUW-220D; Shimadzu, Tokyo, Japan) with an accuracy of 10⁻⁵ g. Holes were created in the rubber stoppers of the vials with a hot instrument. A tooth was inserted through the rubber stopper under pressure and fixed at the cemento-enamel junction using cyanoacrylate (Quickstar; Furkan, Istanbul, Turkey). The rubber stopper with the tooth was then fitted to the mouth of the vial. The apical part of the root was suspended within the vial, which acted as a collecting container for the apical material extruded through the foramen of the root. A 25-G needle was placed through the rubber stopper to equalize the air pressure inside and outside the vial.

The teeth were divided randomly into 5 groups as follows:

Group 1: ProTaper Universal retreatment files D1 (#30 .09), D2 (#25 .08), and D3 (#20 .07) were used according to the manufacturer's instructions with a gentle in-and-out motion to the WL for gutta-percha removal.

Group 2: The same procedure as in group 1 using Mtwo retreatment files (#15 .05 and #25 .05).

Group 3: The same procedure as in group 1 using D-Race retreatment files DR1 (#30, .10) and DR2 (#25 .04).

Group 4: The same procedure as in group 1 using R-Endo retreatment files Rm (#25 .04 hand file), Re (#25, 12), R1 (#25 .08), R2 (#25 .06), and R3 (#25 .04).

Group 5: A Reciproc R25 file (# 25 .08) was used for the WL.

For the final preparation, Reciproc #40 .06 NiTi files were used to the WL. For each specimen, 20 mL distilled water was used for irrigation between files and the pecking sequences during the retreatment and final preparation procedures. Each instrument was used for only 1 preparation.

Retreatment was deemed complete when no gutta-percha or sealer was visible on the instrument surfaces and the canal walls were smooth. A dental operating microscope (Zeiss OPMI; Carl Zeiss,

TABLE 1. Median Weight of Apically Extruded Debris in Groups

Group no.	Group name	Median (25%–75%)
Group 1	ProTaper Retreatment	362.5 (327–386.25) ^a
Group 2	MTwo Retreatment	323 (302–343.5) ^a
Group 3	D-Race	168 (145–189) ^b
Group 4	R-Endo	153 (131–75–190) ^b
Group 5	Reciproc	565 (421–25–712.5) ^c

Different letters indicate statistically significant difference ($P < .001$) (10⁻⁵ g).

Jena, Germany) was used throughout. All procedures were performed by a single operator to avoid interoperator variability.

When the retreatment procedures were finished, the apical part of the tooth was washed with 1 mL distilled water to collect the apically extruded debris that had adhered to the root apex in a vial. The rubber stoppers were removed from the glass vials, which were stored in an incubator at 68°C for 5 days to evaporate any moisture before weighing the dry debris. Glass vials that included dry extruded debris were weighed in the same manner as during the initial measurement. The weight of the extruded debris was determined by subtracting the weight of the preweighed empty glass vials from the weight of the tubes containing dried debris. The durations of retreatment and the final preparation periods were recorded.

Statistical Analysis

Data were subjected to 1-way analysis of variance and the Tukey test using SPSS version 22.0 (SPSS Inc, Chicago, IL). The level for accepting statistical significance was set at $P < .05$.

Results

The median weights of the extruded debris are presented in Table 1 and Figure 1. The median retreatment durations are shown in Table 2 and Figure 2.

Group 5 (Reciproc) produced significantly more debris than all of the other groups. There were no significant differences between groups 1 (ProTaper retreatment) and 2 (Mtwo retreatment), which produced significantly more debris than groups 3 (D-Race) and 4 (R-Endo). There were also no statistical differences between groups 3 (D-Race) and 4 (R-Endo).

Regarding the times, group 5 (Reciproc) was significantly quicker than all of the other groups. There were no statistical differences among the other 4 groups.

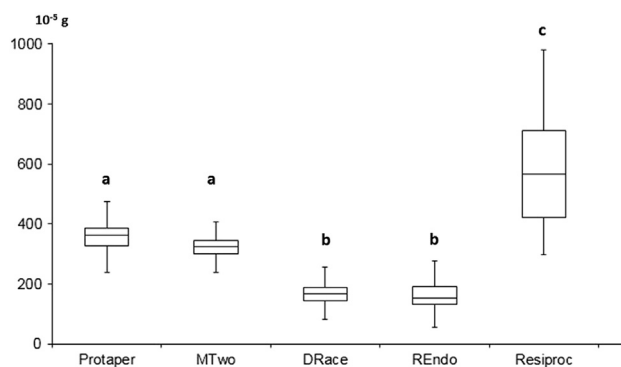


Figure 1. The median weight of apically extruded debris in groups (10⁻⁵ g). Different letters indicate statistically significant difference ($P < .001$).

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