Glide Path Management with Single- and Multiple-instrument Rotary Systems in Curved Canals: A Micro–Computed Tomographic Study

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Abstract

Introduction: Securing a reproducible glide path before instrumentation is recommended to maintain the original geometry of the root canal system and to prevent file separation. Mechanical glide path management systems have been introduced to expedite this step. The aim of this study was to compare apical transportation, canal volume increase, and working time during glide path management with ProGlider (PG; Dentsply Tulsa Dental Specialties, Tulsa, OK) and PathFiles (PF, Dentsply Tulsa Dental Specialties). **Methods:** Forty curved mesial canals of mandibular molars were randomly allocated into 2 experimental groups (n = 20) according to the glide path management system: PG or PF. A glide path was achieved according to the manufacturers' protocol. Micro–computed tomographic analysis was performed to assess apical transportation at 1, 3, and 5 mm and volume increase. The time required to achieve the glide path was measured. **Results:** The overall apical transportation mean values (± standard error) were 13.33 ± 3.37 μm for PG and 19.21 ± 4.4 μm for PF ($P > .05$). The mean (± standard error) volume increase values were 0.49 ± 0.06 mm^3 for PG and 0.48 ± 0.06 mm^3 for PF ($P > .05$). A statistically significant difference in the working time was found between the groups ($P < .0001$) where the mean (± standard error) values for time were 7.38 ± 1.73 seconds for PG and 20.61 ± 5.54 seconds for PF. **Conclusions:** Similar apical transportation and volume increase occurred during glide path management with PG single-file and PF multi-file systems; however, PG achieved glide path faster than PF. *(J Endod 2015;41:1880–1883)*

Key Words

Apical transportation, glide path, micro–computed tomography, ProGlider, PathFile

Endodontic glide path management has been described as the patency from the canal orifice to the apical foramen, and it is considered an important step for the safety of the cleaning and shaping procedure (1). The glide path can be achieved with both hand and rotary instruments (2); however, the performance of this procedure using hand files may be difficult and time-consuming, particularly in teeth with constricted and/or severely curved canals (3). Hence, recent investigations have focused on nickel-titanium (NiTi) rotary instruments to achieve a safe and predictable glide path (2–5).

Clinical procedures and an ideal shaping protocol are still being developed as new instruments continue to be introduced to the market. New versions are rapidly becoming available, and the clinician may find it difficult to choose which file system and/or technique is more suitable for each individual case (6). The PathFile system (PF; Dentsply Tulsa Dental Specialties, Tulsa, OK) consists of 3 instruments with a fixed .02 taper and a square cross section used for the purpose of achieving a glide path. The tip size varies depending on the file number; PF #1 has an ISO .13-mm tip size, the PF #2 has an ISO .16-mm tip size, and the PF #3 has an ISO .19-mm tip size. PF instruments are manufactured out of conventional NiTi alloy (4), and their use is associated with improved centering ability and a reduction of canal aberrations (7, 8).

More recently, a new single-file rotary instrument was introduced to the market also for the purpose of producing a glide path. The ProGlider (PG, Dentsply Tulsa Dental) is manufactured using a heat-treated M-Wire NiTi alloy to enhance flexibility and cyclic fatigue resistance (4), and its design and mechanical features enable the glide path to be created by a single instrument. PG has a square cross section, tip size of .16 mm, a progressive taper (from .02 to .08), and 18 mm of cutting surface. The progressively tapered design allows the PG to provide a preliminary preflaring of the middle and coronal portions of the canal while creating a glide path (5).

Micro–computed tomographic (micro-CT) scanners accurately reproduce internal and external tooth morphology without tooth destruction and have the ability to accurately determine surface and volume changes after instrumentation (9–13). They also allow the superimposition of 3-dimensional renderings of the preoperative and postoperative canal system with high resolution (14).

To our knowledge, no study has yet compared differences in glide path management using PG and PF with regard to apical transportation, canal volume increase, and working time.

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Materials and Methods

The research design was approved by the University of Manitoba Research Ethics Board (H2014:311).

Sample Selection

Twenty fully developed human mandibular molars with 2 separate curved mesial roots ending in 2 separate foramens and with an average curvature of 34° as determined by Schneider's method (15) were selected for this study. The sample size was determined based on previous studies of this nature (2, 3, 13, 16–18). All experimental procedures were performed by 1 endodontist. The crowns were flattened with steel disks, and a standardized length of 16 mm was achieved for each tooth.

Micro-CT Analysis

Pre- and postinstrumentation micro-CT scans were performed to allow for a nondestructive, quantitative assessment of both volume increase and apical transportation. Individual custom jigs were fabricated to ensure that each specimen was placed exactly in the same position for pre- and postinstrumentation imaging. The SkyScan 1176 micro-CT system (Bruker microCT; Bruker, Aartselaar, Belgium) was used to scan all teeth, and all scanning and reconstruction parameters were kept constant for pre- and postinstrumentation scans (scanning: source voltage: 80 kV, current: 313 μm, 18-μm resolution, copper and aluminum filter, 83-second exposure time, 0.7° rotation step, and 360° acquisition; reconstruction: ring artifact reduction factor of 10 and beam hardening correction of 30%). CTAn v1.10.1.0 software (Bruker-microCT, Kontich, Belgium) was used for the 3-dimensional volumetric visualization analysis and measurement of the volume increase. Comparison of the equivocal 2-dimensional slices obtained before and after instrumentation allowed for direct visualization of the location, amount, and direction of apical transportation (Fig. 1). The 3 sections of interest were 1, 3, and 5 mm from the foramen. The sections were determined by identifying the slice in which the foramen was first visible (0-mm mark) and then adding 56 slices to achieve the first mm followed by 112 slices to achieve 3 mm and another 112 slices to achieve 5 mm. The same slices were compared pre- and postinstrumentation.

Experimental Procedures

Access to the canal was obtained in the conventional manner. The canals were negotiated with a #08 hand file (Dentsply Tulsa Dental) in the presence of 5% sodium hypochlorite, and the working length (WL) was determined under 10× magnification (Carl Zeiss, Oberkochen, Germany) by advancing the same file until it was visible at the apex and then subtracting 0.5 mm from this length. The initial glide path was created with #08 and #10 hand files (Dentsply Tulsa Dental). The canals were then randomly divided into 2 groups using a computer algorithm (http://www.random.org) according to the system for glide path management in which 1 canal of each tooth was allocated to PG and the other to PF. The PG single-file glide path was achieved with the PG rotary file (016, .02 at tip level, with progressive taper). The PF system glide path was achieved with PF rotary instruments #1 (13/.02), #2 (16/.02), and #3 (19/.02). Equal numbers of mesiobuccal and mesiolingual canals were allocated to both sample groups during randomization. The files were used following the manufacturer's instructions.

Only new instruments were used for the following procedures. In both groups, all the instruments had to reach the WL. Files were powered by an electric engine (ProMark, Dentsply Tulsa Dental) operated at 300 rpm with a 16:1 reduction handpiece and 5-Ncm torque. Canal irrigation was executed with 2 mL 5% sodium hypochlorite delivered with a 27-G needle attached to a syringe (Endo Eze; Ultradent Products Inc, South Jordan, UT) after each file insertion. Patency was maintained with a #08 K-file set 1 mm past the WL and used after every irrigation cycle. Canals were irrigated with 3 mL 17% EDTA after glide path procedures were completed in each group. After glide path management, micro-CT scans were taken as previously described.

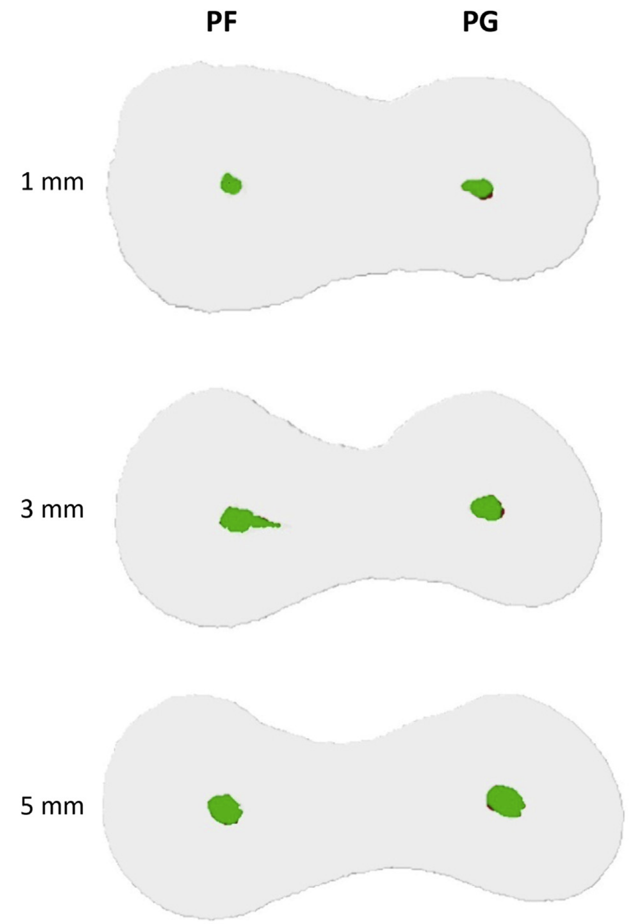

Figure 1. Cross sections of the superimposed root canals before (*green*) and after (*red*) glide path management.

Working Time

The working time for glide path management was measured and recorded in seconds with a digital chronometer set only when the files were rotating inside the canal.

Assessment of Apical Transportation

Two calibrated examiners, blinded as to which file system had instrumented which canal, measured the cross-sectional images using DataViewer software (Bruker-microCT). The final values were obtained by taking the mean of the examiners' measurements. The method modified by Gergi et al (19) was used whereby the shortest distance from the periphery of the canal to the periphery of the root was measured. Pre- and postinstrumentation measurements were compared to assess the magnitude and direction of apical transportation using the following formula: $(X1 - X2) - (Y1 - Y2)$, where X1 represents the shortest distance from the mesial edge of the uninstrumented canal to the mesial edge of the root, Y1 is the shortest distance from the distal edge of the