Comparison among Manual Instruments and PathFile and Mtwo Rotary Instruments to Create a Glide Path in the Root Canal Preparation of Curved Canals

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Abstract

Introduction: Nickel-titanium rotary instruments reduce procedural errors and the time required to finish root canal preparation. The goal of this study was to evaluate the occurrences of apical transportation and canal aberrations produced with different instruments used to create a glide path in the preparation of curved root canals, namely manual K-files (Dentsply Maillefer, Ballaigues, Switzerland) and PathFile (Dentsply Maillefer) and Mtwo (Sweden and Martina, Padua, Italy) nickel-titanium rotary files. Methods: The mesial canals of 45 mandibular first and second molars (with curvature angles between 25° and 35°) were selected for this study. The specimens were divided randomly into 3 groups with 15 canals each, and canal preparation was performed by an endodontist using #10-15-20 K-type stainless steel manual files (group M), #13-16-19 PathFile rotary instruments (group PF), and #10-15-20 Mtwo rotary instruments (group MT). The double digital radiograph technique was used, pre- and postinstrumentation, to assess whether apical transportation and/or aberration in root canal morphology occurred. The initial and final images of the central axis of the canals were compared by superimposition through computerized analysis and with the aid of magnification. The specimens were analyzed by 3 evaluators, whose calibration was checked using the Kendall agreement test. Results: No apical transportation or aberration in root canal morphology occurred in any of the teeth; therefore, no statistical analysis was conducted. Conclusions: Neither the manual instruments nor the PathFile or Mtwo rotary instruments used to create a glide path had any influence on the occurrence of apical transportation or produced any canal aberration. (J Endod 2012;38:117–120)

Key Words
Digital radiography, glide path, Mtwo, PathFile, rotary instruments

For endodontic treatments to be successful, it is essential to maintain the original configuration of the root canal system, without causing any iatrogenic event (1). Nickel-titanium (NiTi) rotary instruments represent an evolution in standardizing canal preparations (2, 3). A well-centered preparation with these instruments in curved canals has required less time than that needed with manual instruments (4, 5).

In clinical practice, NiTi rotary instruments present a certain fracture risk, mainly as a result of flexural tension (fatigue) and torsion (shearing) (6, 7). Canal curvature is considered the preponderant risk factor in flexion-caused instrument failure (8, 9). The instrumentation technique used may play a significant role in preventing torsional stress that can increase dramatically as a result of excessive pressure on the hand piece (10), of an extensive contact area between cutting surface of the instrument and canal walls (5, 11), or of the cross-section of the canal being smaller than the size of the nonactive or noncutting tip of the instrument (5, 11). Both situations might cause what has been described as taper lock. Until now, it was known that this risk may be reduced by performing manual preflaring previously to rotary instrumentation with NiTi instruments (12, 13). Thus, the diameter of the root canal should be greater or at least the same size as that of the tip of the first rotary instrument used (14, 15).

Most NiTi rotary systems recommend the crown-down instrumentation technique, and initial access with manual stainless steel files to reduce the risk of fracture and apical transportation (16, 17). NiTi rotary instruments have been recently introduced on the market for the purpose of creating an initial glide path and eliminating the need for previous manual instrumentation. Mtwo NiTi rotary instruments (Sweden and Martina, Padua, Italy) have an S-shaped cross-section, a nonworking tip, a positive inclination angle, 2 cutting edges, and different tapers. According to the manufacturer, this design prevents fracture and the transportation of debris toward the apex. Each instrument creates an access way for the next sequential instrument, up to the apical region, and all instruments are used up to the working length.

Another NiTi system was recently introduced by Dentsply Maillefer (Ballaigues, Switzerland) for the same purpose of creating an initial glide path mechanically. According to the manufacturer, the PathFile is a system composed of 3 instruments with a square cross-section and .02 taper. The first file of the PathFile sequence is recommended for use immediately after exploring the root canal with a #10 manual K-type file. The aim of the present study was to compare the occurrence of apical transportation and canal aberrations observed after manual instrumentation with K-type files, with that observed after mechanized instrumentation with Mtwo and PathFile instruments to create a glide path in curved root canals.
Materials and Methods

Specimen Preparation

Forty-five first and second human mandibular molars with curved mesial canals (angles between 25° and 35°) extracted for periodontal reasons were stored in physiological saline solution until use. The distal root of each tooth was removed with a diamond disk, together with the coronary portion exceeding the length of 12 mm, adopted for specimen standardization. Confirmation of foraminal patency was performed with a number 08 or 10, stainless steel manual K-type file. The working length was determined by subtracting 1 mm from the length measured when the tip of the file was first observed emerging from the apical foramen.

Using a modified method of that described by Maggiore (18), a series of radiographs was taken, and Adobe Photoshop CS2 software (Adobe Systems Inc, San Jose, CA) was used to enhance the contrast of the pre- and post-preparation radiographs. The curvature angle of the canals was determined according to the method described by Pruett et al (8). Canals with curvatures between 25° and 35° were included in the study and randomly divided into 3 groups with 15 canals each.

The roots were embedded in a jig constructed with transparent, thermally activated acrylic resin (Orthoplast, Zeist, Netherlands) so that they could be removed for preparation and later reinserted in a predetermined position for the purpose of comparing the images taken before and after preparation using standardized radiographic imaging. To allow accurate superimposition of the pre- and postoperative images, the head of the x-ray tube was fitted to a cylinder-shaped apparatus so as to remain stationary and at a constant distance from the digital sensor used to acquire all of the images. The acrylic jig containing the root was then positioned at the center of the sensor so as to align perfectly with a square-shaped guide previously designed on the sensor, thus allowing the jig to be accurately repositioned during the experimental procedure.

Root Canal Instrumentation

Different instruments were used in each of the 3 groups (n = 15) to create an initial glide path: group M: K-type manual files; group MT: the 3 initial files of the Mtwo system; and group PF: PathFile system. The preparations were performed by a single operator specialized in endodontics as follows: (1) group M: the specimens were instrumented with #10, #15, and #20 stainless steel manual K-type files using the balanced-force technique (19); (2) group MT: the specimens were instrumented with #10/04, #15/05, and #20/06 Mtwo instruments; and (3) group PF: the specimens were instrumented with instruments 1, 2, and 3 of the PathFile rotary system.

In all groups, the instruments were used up to their total working length. In the groups in which a rotary system was used (MT and PF), the preparations were performed with permanent rotation, in-and-out movements, an electrical motor (X-Smart, Dentsply Maillefer), a 16:1 reduction contra-angle, and the speed and torque levels suggested for each instrument by the respective manufacturers.

After each instrument change, irrigation with 5 mL of 2.5% sodium hypochlorite (total of 20 mL per canal) was conducted using a syringe with a plastic needle (Hawe Max-I-probe; kerr-Hawe, Bioggio, Switzerland) inserted as far as possible into the root canal without excessive pressure. Once the instrumentation was completed, 1 mL of 17% EDTA was applied for 3 minutes followed by final irrigation with 3 mL of sodium hypochlorite. Each instrument was used in 3 canals and then discarded.

Evaluation of the Root Canal Preparation

After performing the preparations, the roots were repositioned in a predetermined position in the acrylic jig, and postoperative radiographs were taken with a #15 stainless steel manual file inside the canal. The digital radiographs were saved in JPG format and imported into Adobe Photoshop CS2 software. The images of the pre- and post-instrumentation radiographs were then superimposed to compare the differences between pre- and post-instrumentation canal geometry. The digital radiographs were taken in the same apparatus for the whole sample, and the data were stored in an optical magnetic disk. The parameters assessed by 3 blinded endodontists with research experience were aberrations in canal morphology (ie, ledges, changes in the angle of canal curvature, and elbows) and the occurrence of apical transportation. The number of fractured instruments was also recorded. The Kendall test was used to assess interexaminer agreement. No statistical analysis was conducted because there were no occurrences of apical transportation or canal aberrations in any of the teeth.

Results

The application of the Kendall test revealed a high degree of interexaminer agreement (P > .999). Two teeth from the MT group were lost as a result of instrument fracture, both of them while using the #10/04; however, these teeth were replaced. No occurrence of apical transportation or aberration in canal morphology was observed in any of the teeth in the 3 experimental groups. After preparation, the foramen kept its same initial pre-preparation position, and the shape of the prepared canal maintained the same central axis existing before the preparation was performed, albeit with widened lateral dimensions because of the uniform wear caused by the instruments applied to the canal walls.

Discussion

One of the main goals of root canal preparation is to increase the canal’s apical-to-cervical taper while maintaining its original overall shape (20). A number of procedural errors, such as apical transportation, may occur during the shaping of curved canals (21). To investigate the efficiency of the instruments and techniques developed for root canal preparation, a number of methods have been used to compare canal shape before and after preparation. One such method is digital radiographic imaging.

In clinical practice, radiographic visualization to assess apical transportation is often conducted by analyzing radiographs in a buccolingual direction (the 2-dimensional image of a periapical radiograph). However, this method measures the projection of the transportation and not the actual transportation because dental roots do not always reveal the full extension of their curvatures on the mesiodistal or buccolingual planes. In the present study, a modified method of that described by Maggiore (18) was used to obtain the radiographic projection closest to the actual maximum curvature of the root canal, thus establishing the actual angles more accurately.

Statistically, the standard deviation of observations may increase when curved specimens are used. Some studies have used standardized artificial canals in training blocks to minimize this problem (22). However, in our opinion, the benefit derived from testing file systems in the natural dentin of extracted teeth (therefore under more realistic conditions) is greater than the benefit derived from observing smaller standard deviations in artificial canals. That is why we used natural teeth in the experiment conducted in the present study.

On the other hand, contrasting with the study by Berutti et al (22), who also studied the influence of the operator’s expertise on the incidence of canal aberrations and canal curvature changes after...
preflaring with hand K-files and rotary PathFile instruments, our study focused mainly on comparing the safety of using manual instruments and rotary instruments as measured by the outcomes obtained by a single expert operator (an endodontics specialist). Therefore, further studies may be conducted to assess the influence of the operator’s expertise on glide path creation outcomes using the systems assessed in our study (Mtwo and PathFile) and in natural human teeth.

The frequent use of curved canals as specimens in research can possibly be explained by the fact that these canals pose a greater challenge to instrumentation. This difficulty has been correlated with the observation of performance differences between different instrument systems (22–24). Furthermore, the evaluation of the changes in canal curvatures after instrumentation has been widely used to assess the tendency of a given technique or of the mechanical properties of a certain instrument to maintain the original anatomy of the canal or rectify its curvatures (22, 25).

Blum et al (11) suggested creating a glide path manually with flexible stainless steel files in canals in which there is not enough space to introduce rotary instruments. Berutti et al (14) confirmed the need for preflaring up to K file #20 before using ProTaper instruments in order to guarantee sufficient space for the SI file, whose tip measures 0.17 mm. These authors report that the reduction in torsional fatigue allowed a 6-fold increase in the average number of uses before discarding, thus reducing treatment costs and the risk of instrument fracture inside the canal. There are different opinions about using an initial glide path, created manually before using rotary systems (4, 5, 26–30).

Manual preflaring and coronal enlargement (12, 13), performed to create initial access, have proven essential to allow safer use of NiTi rotary instrumentation (14, 15). The initial inspection of the canal and preflaring are the first instrumentation steps, during which higher rates of procedural difficulties or errors may occur (31). NiTi rotary systems usually use the crown-down technique. This technique reduces the friction involved in cutting dentin inside the canal because only part of the file is applied to the canal walls. This relatively less friction reduces the incidence of apical transportation because files go into the canal more freely (32).

Contrasting with this concept, Mtwo and PathFile files are used without prior manual preflaring or coronal enlargement and are applied up to the total working length (5, 22). This working method implies that the initial files will come across greater friction in the canal, which could lead to a greater chance of instrument fracture. Nevertheless, the difference between the crown-down and the total length techniques in terms of torsion strength have not yet been sufficiently investigated (26). Plotino et al (27) concluded that the Mtwo rotary instruments may be used safely under clinical conditions in molars with severe curvatures.

Velti et al (28) analyzed the Mtwo and Hero Shaper systems (Micro-Mega, Besançon, France) in molars with curvatures between 24° and 69°. They concluded that these systems are effective in shaping curved canals and in producing well-centered preparations without any aberration. Tripi et al (33) studied the flexural fatigue of different NiTi instruments, size 0.25 mm and 6% taper, and concluded that Mtwo and Hero may be selected to enhance safety in complex cases.

Berutti et al (22) compared the curvature changes and aberrations observed after conducting preflaring with manual K-files or PathFile rotary instruments. They concluded that the PathFile system presented a significantly smaller change in canal curvature and fewer aberrations. In our study, 2 #10/04 Mtwo files fractured. This could have occurred because their tips (where the fractures were observed) have a smaller caliber. In this part of the instrument, they are more prone to flexion and to torsion-caused fracture (even under lower torque values).

Similarly, other studies have reported that smaller instruments have greater chances of presenting distortion and fracture than larger ones (34, 35). Although the variable time of preparation was not the object of the present study, the mean time required by the 3 different types of instruments to create the glide path were similar. In conclusion, no occurrence of apical transportation or aberration in canal morphology was observed after preparation in any of the experimental groups. Thus, there was no difference between manual instruments and PathFile or Mtwo rotary instruments used to create a glide path in the endodontic preparation of curved canals.

Acknowledgments

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References