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Comparison of PathFile and ProFinder systems to create a glide path in curved root canals

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ABSTRACT

Objective: Root canal shaping is as important as irrigation and filling when attempting to obtain a high success rate in endodontic treatment. The creation of a glide path before the use of rotary instruments reduces the risk of posterior iatrogenic errors. The objective of the present study was to evaluate instrumentation time and root canal transport after using 2 different glide path rotary systems.

Methods: In total, 60 mesiobuccal root canals of mandibular molars, with curvature angles between 11° and 82°, were standardized to measure 15 mm. The specimens were divided into 2 groups, depending on their angles of curvature (11º–38º and 39º–82º), and further divided into 4 groups (n=15). Two groups were instrumented using the PathFile system and the other 2 using the ProFinder system. The angle and radius of curvature were measured at the most abrupt angle of curvature before and after instrumentation. Both measurements were analyzed and compared using AutoCAD software to determine canal transportation. Curvature angles were compared using Student's t test and the radii of curvature using the Wilcoxon test. The time for instrumentation was also evaluated using Student's t tests.

Results: There were no statistically significant differences between the two systems with respect to root canal transport (P>0.05); however, the ProFinder system took a longer time to create a glide path (P=0.004)

Conclusion: Both systems were equally effective in creating a glide path; however, the PathFile system proved to be faster than the ProFinder system.

Keywords: Curved root canals, glide path, PathFile, ProFinder

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HIGHLIGHTS

- To maintain the original shape of the root canal from coronal to apical third is one of the main goals of endodontics.
- The PathFile and ProFinder systems are both capable of creating an adequate glide path.
- The Ni-Ti rotary PathFile system is faster than the manual ProFinder system.

INTRODUCTION

Although successful endodontic therapy depends on many factors, one of the most important factors is the shaping of the root canal system. Proper cleaning and filling of the root canal system is facilitated by the maintenance of its original shape from the coronal to the apical thirds, without any iatrogenic event. When instrumentation is performed in a canal that has a marked angle or small radius of curvature, the possibilities of transporting the canal or creating an apical zip increase (1, 2). Many studies mention the importance of creating a glide path prior to using rotary instruments to reduce instrument fatigue (3-7, 8), thus increasing the instrument's life span by diminishing fracture rates and preventing shaping errors (6-9).

The PathFile system (Dentsply Maillefer, Ballaigues, Switzerland) was introduced to the market in 2009 as the first pathfinding rotary instrument with the sole purpose of creating a glide path. This system comprises 3 instruments that measure 13, 16, and 19 mm at D0, having a constant taper of 2% and a square cross-section; it has been proposed as a safer system than stainless steel K-files constant taper (7).

The ProFinder® system (Dentsply Maillefer, Ballaigues, Switzerland) also has 3 stainless steel hand instruments with tips of 10, 13, and 17 mm, with a decreasing taper that differentiates it from the classical stainless steel K-files, which help to create a glide path when done by hand.

There is need for a more extensive analysis of the ability of different files to maintain the original anatomy; therefore, the objective of the present study was to evaluate instrumentation time and root canal transport after using 2 different glide path rotary systems.

MATERIALS AND METHODS

The present study was designed with the approval of the ethical and research committee of the Universidad Europea de Madrid (Madrid, Spain), where the investigation was conducted. The required sample was calculated by a statistician using nQuery software (Statistical Solutions, Saugus, MA, USA), with a 90% power and the significance level at 0.05. It was found that 15 samples per group were required. Sixty mandibular molars extracted for periodontal reasons were stored in 2% thymol prior to their use. All the molars were immersed in 2% NaOCl for 2 hours, and all visible calculi were removed using ultrasonic tips. For tooth standardization, the distal roots were removed and the crowns reduced until the mesiobuccal canals measured 15 mm. Roots with an open apex or calcified or double curvature canals, or those that underwent root resorption or previous endodontic treatment were discarded. Only roots with radiographic confirmation of Vertucci's type IV root canal configuration in the mesiobuccal root were selected. All the roots were immersed in alginate, and a series of radiographs were taken through a collimator placed on a marked platform, to determine the location of the root's greatest curvature (10) and the radius. Their angle of curvature was determined as described by Pruett et al. (1) using AutoCAD 2008 (Autodesk Inc, San Rafael, CA, USA). Samples ranging from 11°to 82° were included. The 60 roots were divided into 2 groups (n=30): the first group comprised moderate curvatures ranging from 11° to 38° (Group 1) and the second comprised extreme curvatures ranging from 39° to 82° (Group 2). The methodology used in the present study was as described previously (6). These two groups were further subdivided by stratified random sampling, resulting in 4 groups (n=15) (Fig. 1).

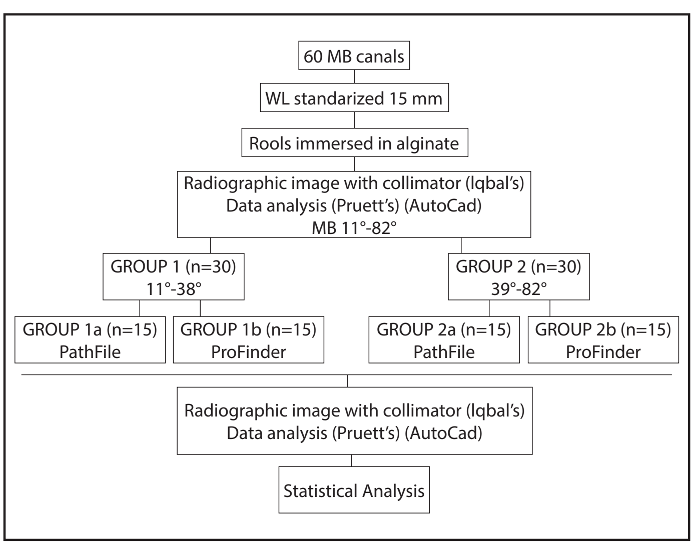

Figure 1. Flowchart of the methodology

Root canal instrumentation

All mesiobuccal canals were instrumented by an experienced endodontist, with 5 years of clinical experience, using rotary instruments and following manufacturer's instructions. A precurved #10 K-file (Dentsply Maillefer, Ballaigues, Switzerland) was used for the scouting of the canal to the established working length (WL) (15 mm), after which canal instrumentation was performed as follows:

PathFile Groups (1a and 2a): the rotary instruments were used at 300 rpm with a torque value of 5 Ncm; the instruments were mounted on a 16:1 contra angle in the X-smart device (Dentsply Maillefer, Ballaigues, Switzerland). Rotary instrument sizes 1, 2, and 3 were used to WL.

ProFinder Groups (1b and 2b): a ProFinder #10 K-file was used, followed by #13 and #17, using a balanced-forced technique (11). Finally, a #20 manual Ni-Ti instrument (Dentsply-Maillefer, Ballaigues, Switzerland) was used to WL.

In all the groups, irrigation was accomplished with 1.5 mL of a 4.2% NaOCl solution between each instrument, and each instrument was used in 3 canals.

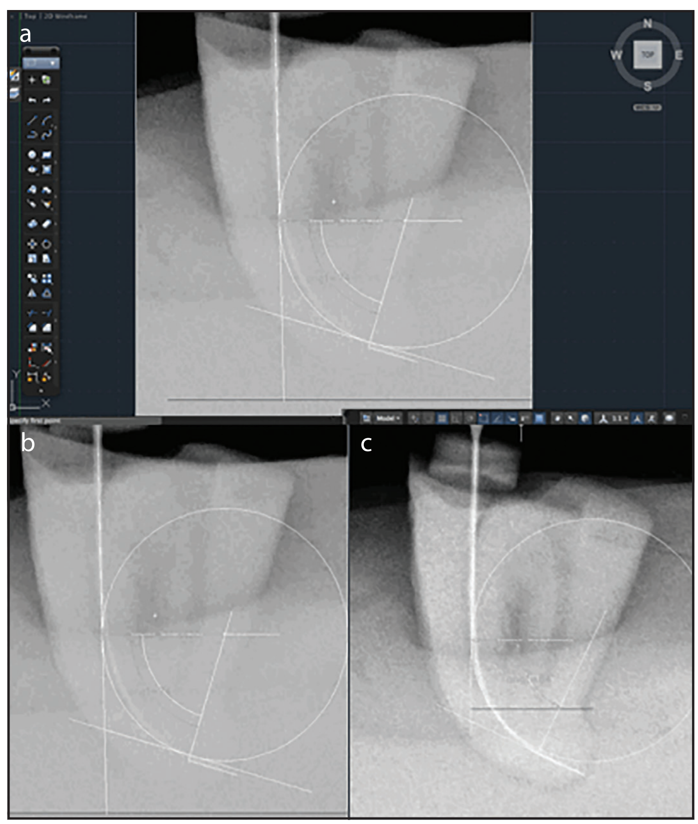

Figure 2. a-c. Images of calculation of the angle of curvature with the AutoCAD 2008. (a) Calculation of the angle and radius of curvature with the computer informatic sprogram. (b) Calculation of pre-instrumentation. (c) Calculation of post-instrumentation

TABLE 1. Statistical analysis of the experimental groups

Mean and SD of angles in grades	Previous Angle (SD)	Post Angle (DE)	Angle difference (post-pre angle)	Statistical comparison
Pathfile	37.8 (18.5)	32.93 (19.26)	4.83 (6.03)	p=0.0001
Profinder	39.1 (19.2)	31.53 (21.48)	7.53 (7.85)	p=0.0001
Statistical comparison (t-Student)	p=0.791		p=0.141	
Median (percentile 50) of radii in grades	Previous radii	Post radii	Radi difference (post-pre radi)	Statistical comparison
Pathfile	283.2	225.26	-323	p=0.393
Profinder	287.9	260.81	5.03	p=0.491
Statistical comparison (U Mann-Whitney and W Wilcoxon)	p=0.442		p=0.393	
	Mean Time in seconds (SD)			
Pathfile	47.17 (6.89)			
Profinder	54.00 (10.24)			
Statistical comparison (t Student)	p=0.004			

A radiograph of all the roots was taken in the position determined as "greatest curvature."

The time for canal preparation was measured using a stopwatch, and the total of the active instrumentation, changes in instruments, and irrigation were included.

No canal aberrations or deformations or fractures of the instruments were noted.

Evaluation criteria

Pre- and post-radiographic digital images were taken from the same position utilized for measuring the angle of curvature and radius, using the method described by Pruett (1) (Fig. 2), by the software AutoCAD 2008 (Autodesk Inc, San Rafael, CA, USA). PhotoShop CS2 9.1 (Adobe System Inc, San Jose, CA, USA) software was used to improve image sharpness.

Statistical analysis

To determine if the characteristics of the samples were comparable, the mean pre-instrumentation measurements of the angle and radius were analyzed. For the angle measurements, the mean and standard deviation (SD) were both used because the data presented a Gaussian (normal) distribution. For the radius measurements, the mode and interquartile range were used because the data presented a non-normal distribution. To compare the means of the pre-instrumentation angles, the independent Student's t test was used, which was also employed to compare the time required to instrument the root canals by both systems. To compare the means of the pre-instrumentation radii, a nonparametric Mann-Whitney U test was used. Alteration of the angles and averages in altering the pre- and post-radius of curvature in each group were evaluated by the medians of angles and Student's t tests, as well as the mode of the average radius measurements and the nonparametric Wilcoxon test for nonrelated samples. The mean was calculated to compare the influence of the angle in each experimental group.

RESULTS

The means of the pre-instrumentation angles between the PathFile and ProFinder groups were not statistically different (P=0.791). The medians of the pre- and post-instrumentation radii when comparing both systems were not statistically significant (P=0.442). Using both systems, the angle of curvature was reduced after instrumentation (Table 1); differences between the pre- and post angles were more pronounced in the ProFinder group, but they were not statistically significant (P=0.141).

Using the PathFile system, changes in the pre- and post angles and radii were not significant between Groups 1 and 2 (P=0.883 and P=0.272, respectively). When the ProFinder Groups 1 and 2 were analyzed, the same results regarding the changes in the pre- and post angles and radii were observed (P=0.557 for the angles; and P=0.237 for the radii).

When comparing the time utilized by the PathFile and ProFinder systems to prepare the root canal, there were statistically significant differences between the 2 groups, and the ProFinder system took a longer time to create a glide path than that taken by the PathFile system (P=0.004).

DISCUSSION

Numerous methods have been employed to study the shape of the canal before and after its conformation (7,9,12,13-15). Some studies evaluating the shaping of the root canals by micro-CT (9, 15-17) have been published, which show that it is a non-invasive method that accurately reproduces the three-dimensional internal and external tooth morphology, allowing the superimposition of renderings of the preoperative and postoperative canal system with high resolution (9). Nevertheless, the radiographic method has been used by several researchers to assess root canal curvature (6, 10, 18).

The angle of curvature described by Pruett et al. (1) defines more clearly the difficulties of treatment because 2 canals with the same angle may present different radii. In the study reported by Varela Patiño et al. (4), the angle of curvature was used to measure the apical transportation of the root canal, whereas Berutti et al. (7) utilized the curvature and radius to measure the original deformation of the root canal. In the present study, we attempted to simulate the clinical situation by measuring both the angle and radius of curvature.

To the best of our knowledge, only few studies that compare the glide path performed by manual or rotary instruments have been conducted (7-9,12,19-22). The results of our study show no statistically significant differences in the modification of the angle or radius of curvature between the 2 experimental systems. In contrast, we observed more angulation changes pre- and post-instrumentation in the ProFinder groups, which may have been due to the stiffness of stainless steel compared with the flexible Ni-Ti in the PathFile system, observing the same behavior of the files in moderate and severe curvatures.
In a study conducted by Berutti et al. (7), the PathFile system was compared to a manual glide path created by stainless steel instruments utilized by both experts and non-experts. They found that the PathFile system was better able to preserve the original anatomy when used by both experts and non-experts, with the differences being statistically significant. In contrast to our study, Berutti et al. used the PathFile #3 (D0: 19) or a #20 K file in the canal to take the final radiograph. We also used a #20 K in all cases for the final radiograph, but the instrument was of Ni-Ti to allow for better adaptation of the file to the irregularities of the canal. In addition, they used simulated resin blocks to perform their research. In another study by the same authors, using micro-CT, the PathFile was better able to maintain the original anatomy of the root canals and created less aberrations than those created by K-files used to create the glide path (9). The authors described the technique used for the hand instrumentation as a "feed it in and pull" motion, which is probably different compared with the technique proposed by Roane (11) and used in our study.

Oliveira Alves et al. (12), in concordance with the results of the present study, did not find any differences regarding canal transportation when comparing the PathFile system to hand files.

The time taken by both techniques, manual or rotary, is important from a clinical perspective and should be taken into consideration. We observed statistically significant differences regarding the same and found that the PathFile system was faster. The time taken to perform the glide path using different systems has been previously evaluated and compared (4, 20, 21, 23). In concordance with our findings, the results of a recent research conducted by Paleker et al. (20) show that the rotary files analyzed in their study (G-File and ProGlider) are faster than the manual files used to create a glide path. Another recent study (21) compared the glide path enlargement times of the ProGlider, PathFile, X-Plorer Canal Navigation Ni-Ti files, and stainless steel K-files. They found that the ProGlider was faster, which could be due to the difference in the number of files present in each system. These findings are in agreement with those observed by D'Amario et al. (8), who found that the system with less files is faster.

However, the use of manual files to create a glide path presents some advantages, such as improved tactile sensation, a decreased risk of file fracture, and decreased cost (21).

Due to the greater investment for the realization of a rotary glide path, further studies should be conducted to determine its advantages over hand files.

CONCLUSION

Within the limitations of the study, it can be stated that both systems, the Ni-Ti rotary PathFile and the manual system ProFinder, are able to create an adequate glide path, while maintaining the original anatomy of the root canal. However, the PathFile system was found to be faster than the ProFinder system.

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Disclosures

Ethics Committee Approval: The study was approved by the Local Ethics Committee.

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