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Evaluation of Canal Transportation after Using Different Types Rotary Glide Path Files

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ABSTRACT

Introduction: Canal transportation is a common problem caused by rotary instruments. The purpose of the present study was to evaluate root canal transportation after using WaveOne Gold Glider, ProGlider, Path File and K-file. **Methods and materials**: Forty resin blocks with L-shaped canals were divided into four groups (n=10). Group 1; canals were prepared with WaveOne Gold Glider, group 2; ProGlider, group 3; Path Files and group 4; #10, #15, and #20 stainless steel manual K-Files. Pre- and post-instrumentation photographic images were superimposed and resin removed from the inner and outer surfaces of the root canal was calculated through 3 points at 3, 6 and 9 mm from the end of canal which represented canal transportation. All data were analyzed by one way ANOVA test. The level of significance was set at 0.05. **Results**: Statistical analysis by one-way ANOVA test revealed that there was no significant differences (P>0.05) between the tested files in canal transportation in apical, middle and coronal third. The last amount of canal transportation happened at the apical third in WaveOne Gold Glider group. **Conclusions**: This *in vitro* study showed that using WaveOne Gold Glider files lead to less canal transportation especially in the apical third area with less significant differences with ProGlider, PathFiles and K-File.

Keywords: Canal Transportation; Glide Path File; Resin Block; WaveOne Gold Glider

Introduction

Removal of infected tissue remnants is the main goal of root canal treatment which can be achieved with chemo-mechanical preparation [1]. During the last years, root canal preparation was performed with hand files which carry the risk of straightening root canals and resulting in complications including ledging, zipping and canal transportation [2]. Especially, in curved canals, preserving original canal morphology and avoiding procedural errors are important projections of root canal preparation [3].

Pre-enlargement of canals is sometimes required to decrease the risk of fracture of NiTi instruments inside the canal. With pre-enlargement a glide path is created that facilitates the penetration of rotary instruments regardless of the technique used. Traditionally pre-enlargement and glide paths are achieved with manual steel instruments, K-Files #10, #15, and #20, used sequentially [4]. Despite the new rotary instruments introduced specifically for pre-flaring, the manual technique had many advantages such as: greater tactile control, lower risk of instrument fracture, the ability of precurving the instrument in order to prevent ledges and false channels. However, it also has many disadvantages such as: long operation times and a higher possibility of instrument deformation that makes its working in very long and sharply curved canals more difficult; in addition to the use of an excessive number of instruments and the formation of ledges and apical transportation if used improperly [2]. These led to the introduction of the first mechanical NiTi pre-flaring instruments such as the Path Files (Dentsply Maillefer, Ballaigues, Switzerland). The Path Files are 3 instruments with tip diameters of #13, #16, and #19 characterized by a 0.2 constant taper, elevated flexibility, due both to the NiTi alloy and slight taper [4].

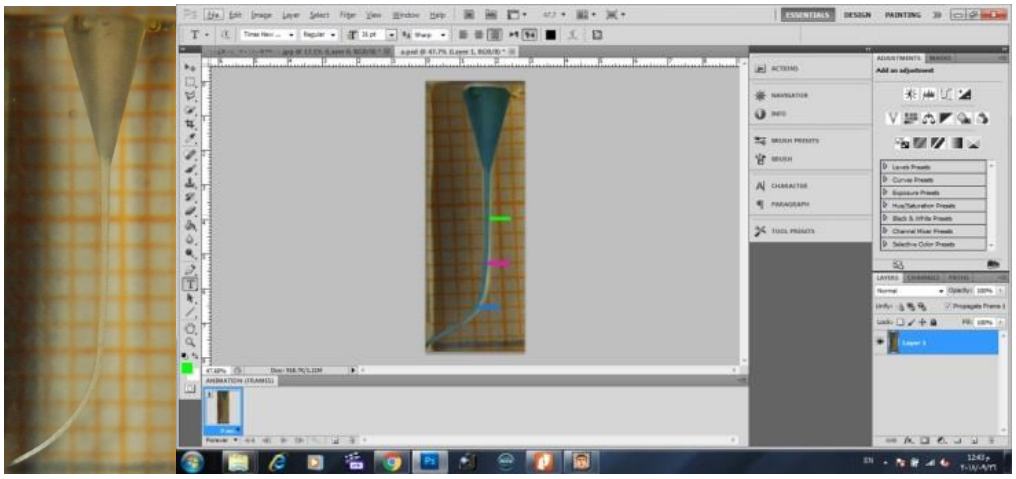

Figure 1. A) Pre-instrumentation image; *B)* Post-instrumentation image superimposed over the pre-instrumentation image in Photoshop

The principal features of the ProGlider (Dentsply Maillefer, Ballaigues, Switzerland) are: M-wire alloy, square cross section with semi-active tip, and a single size of 16/0.02 with variable progressive taper; the active component is 18 mm compared to 16 mm in the Path Files, and three different lengths are available: 21 mm, 25 mm, 31 mm. The 11-mm handle is in gold colored brass and is individually blister packed [5]. After exploring the canal with a K-File #10, the instrument is used in continuous rotation at 300 rpm and 2 N/cm, until it reaches the desired length. Preliminary studies have shown that ProGlider, like their predecessors Path Files, better preserve canal anatomy compared to steel files [5].

The new single glide path files WaveOne Gold Glider (Dentsply Maillefer, Ballaigues, Switzerland) introduced to markets with enhanced flexibility and resistance to cyclic fatigue. Sterile and ready for single use, this file preserves cutting efficiency, reduces breakage and prevents cross contamination. The WaveOne Gold Glider has gold treatment and is only for use in reciprocating motion with compatible Dentsply Sirona motors and is available in one size 15 with variable tapers 2% to 6% with three different lengths 21, 25 and 31 mm [6].

The aim of this study was to evaluate the amount of canal transportation after using WaveOne Gold Glider, ProGlider, Path Files and K-File.

Materials and Methods

A total of 40 L-shaped resin blocks (VDW GmbH, Munich, Germany) with sizes of 10×10×30 mm were included. For each block, canal length was 19 mm, canal taper was 0.02, apical diameter was 0.15 mm, and radius of curvature was 45°. Blocks were divided into four groups (n=10): Group 1; canals preflared with WaveOne Gold Glider #15/0.02, group 2; canals preflared with ProGlider #16/0.02, group 3; canals preflared with Path-File #1, #2, and #3 and group 4; canals preflared with #10, #15, and #20 stainless steel manual K-Files.

All samples were prepared by using a pre-programmed setting of Electric speed and torque controlled endodontic micromotor WaveOne (Dentsply Maillefer, Ballaigues, Switzerland). All of the roots were prepared according to the manufacturer's instructions and by the same operator, only 6 samples were prepared each time to prevent operator fatigue, canals were rinsed with 2.5% sodium hypochlorite solution with a 27-gauge needle [7]. Digital photography images of pre-instrumentation and post-instrumentation phases were recorded using a Nikon D40 (Nikon, USA) camera with addition of ×3 close up lenses (Figure 1A). The images were saved in JPG format and the post instrumentation digital images were superimposed over the pre instrumentation images using a digital imaging software (Adobe Photoshop, version CS5; Adobe Systems Inc., San Jose, CA) (Figure 1B). Before superimposed images return to the Rhinoceros Soft-ware, four variables were established: the distance, in a real scale, from the center of the canal to the inner and outer margins of the prepared curve canal, in both apical and coronal curvatures. One operator completed all pre-flaring while second examiner who was blind in respect of all experimental groups carried out the assessment of canal transportation. These paired images and the canal width measures obtained, gave us a quantitative evaluation of the incidence of canal transportation after mechanical preparation [8].

The evaluation for possible canal transportation was performed at three positions along canal wall on both proximal sides of the simulated canal (outer and inner); those locations were selected to represent the apical, middle, and coronal levels. The measurement of 3 mm were used to indicate the apical level, 6 mm signified the middle level and 9 mm indicated the coronal

level. Transportation was determined by the amount of resin removed from both the inner (concave) and the outer (convex) portions of the canal at the selected measuring points. The value was assessed by subtracting the amount of resin removed at the outer wall from that removed at the inner wall. This was done according to the formulae: Transportation of the canal: Deviation toward outer side of the canal-deviation toward the inner side of the canal. Positive results mean that transportation occurs mainly on the inner surface of the canal curvature and negative values indicate that transportation occurs mainly on the outer surface of the canal curvature [9].

The collected data were analyzed by ANOVA test (Chicago, IL, USA) at a significant level of 0.05.

Results

Statistical analysis of mean and standard deviation value for canal transportation is summarized in (Table 1). The lowest total mean value of canal transportation was seen at the 6 mm level (0.2124±0.0078) using WaveOne Gold Glider whereas the highest total mean amount of canal transportation was seen at level 9 mm (0.284±0.00313) by Path Files.

ANOVA test showed no significant differences among tested groups (P>0.05).

Discussion

The study consisted of a comparison between resin blocks canal shape prior and after mechanical instrumentation, despite the fact that these resin blocks may not always reflect the file's action in real teeth, they contribute to standardize experimental conditions and have been reported to reliably demonstrate differences in files system performance, probably as a result of their anatomic challenge [10].

Evaluation of modifications in canal anatomy after instrumentation has been widely used to understand how the mechanical properties of file or technique used can influence their shaping ability [11, 12]. Furthermore, clinicians during clinical practice should be aware of the mechanical properties of the chosen instruments to be able to adapt a rotary file system to anatomic challenges.

The present study compared the ability of WaveOne Gold Glider, ProGlider, Path Files and K-File to maintain a similar anatomy to the initial one on L-shaped canals. After preparation, the shape of the prepared canals maintained the same central axes that existed before the preparation which is in accordance with the results of some previous studies [10, 13]. Alves *et al.* [10], have shown that Path File rotary instruments used alone (without a subsequent instrument) did not have any influence on apical transportation or canal aberration when compared with K-type stainless steel manual files. Similarly, D'Amario *et al.* [13] found no differences between K-type files and Path File in apical transportation. Berutti *et al.* [11] and Pasqualini *et al.* [14] suggested that NiTi rotary Path File instruments preserve the original canal anatomy and cause less canal aberrations when compared with K-files. At the apical third there were statistically non-significant differences (P>0.05) in their ability for canal modification as presented in Table 1. This may be related to the fact that these files had anon cutting tips with minimal apical pressure. Apical transportation more than 0.3 mm negatively effect the sealing ability of the filling materials [15, 16]. None of the testing files produce such amount of apical transportation which is in line with other studies [16, 17].

Table 1. Descriptive statistic of the tested groups

Level	File	Mean (SD)	Min	Max	*P*-Value
3 mm	WaveOne Gold	0.2124 (0.00789)	0.20	0.22	0.796
	ProGlider	0.214 (0.02168)	0.21	0.22	
	Path Files	0.218 (0.01871)	0.21	0.22	
	K-File	0.228 (0.00434)	0.23	0.23	
6 mm	WaveOne Gold	0.25 (0.00709)	0.24	0.27	0.798
	ProGlider	0.246 (0.00844)	0.23	0.26	
	Path Files	0.248 (0.00707)	0.24	0.25	
	K-File	0.268 (0.00713)	0.24	0.28	
9 mm	WaveOne Gold	0.2498 (0.00321)	0.24	0.26	0.592
	ProGlider	0.25 (0.00396)	0.22	0.27	
	Path Files	0.284 (0.00313)	0.26	0.29	
	K-File	0.236 (0.00245)	0.21	.25	

It has been reported that ProGlider instrument had a significantly higher flexibility, higher resistance to cyclic fatigue and torsional stress than Path File instruments [18]. Moreover, in a CBCT study, Elnaghy and Elsaka [19] reported that creating a glide path with ProGlider revealed better performance with fewer canal aberrations when compared to instrumentation performed with ProTaper Next with Path File or ProTaper Next, alone.

WaveOne Gold Glider file has been newly introduced to market. Therefore, there are limited reports concerning its shaping ability. According to this study, WaveOne Gold Glider produced less modification in apical canal curvature compared to other tested files with no significant differences. These results may be related to the facts that it had high flexibility and cyclic fatigue and variable taper.

The direction of the transportation occurred more toward the outer aspect at the 3 mm locations and toward the inner aspect of the canal at the 6 and 9 mm. This can be explained by the construction of the files. When files are used to shape curved canals, the restoring forces of the metal in the files return them to their original shape and during straightening of the files toward the outer side of the curvature they apply more pressure removing more material and cut more in this area. This same effect decreases their cutting more coronally along the inner wall. These findings are in agreement with other studies [9].

Conclusion

Under the condition of this study the WaveOne Gold Glider respect the original curvature of the canal with high flexibility and cyclic fatigue.

Conflict of Interest: 'None declared'.

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