

Influence of operator's experience level on lifespan of the WaveOne Primary file in extracted teeth

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Objectives: The aim of this study was to assess the influence of operator experience level on the lifespan of the WaveOne Primary file (Dentsply Maillefer, Ballaigues, Switzerland) in extracted teeth. **Materials and Methods:** Moderately curved canals of extracted maxillary and mandibular molars were randomly distributed into 2 groups: experienced and inexperienced operators. Ten files were allocated to each group ($n = 10$). Each canal was prepared until the working length was reached, and the same file was used to prepare additional canals until it separated. The number of canals prepared before file separation was recorded. The fragment length of each file was measured, and the location of the fragment in the canal was determined. Data were statistically analysed using the independent 2-sample t -test. **Results:** The 2 operators prepared a total of 324 moderately curved canals of maxillary and mandibular molars. There was no significant intergroup difference in the mean number of canals prepared ($p = 0.27$). The average lifespan of the WaveOne Primary file was 17.1 and 15.3 canals, and the longest lifespan was 25 and 20 canals, when used by experienced and inexperienced operators, respectively. There were no statistically significant intergroup differences in separated fragment length and location. **Conclusions:** Within the limitations of this study, operator experience level appears to have no effect on the lifespan of the WaveOne Primary file in preparation of moderately curved canals. Single teeth with multiple canals can be prepared safely even by a novice operator by using a single file. (*Restor Dent Endod* 2013;38(4):222-226)

Key words: Lifespan; Operator experience; Reciprocating; Separation; WaveOne

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Introduction

In clinical practice, nickel-titanium (NiTi) rotary instrument separation can compromise the outcome of root canal treatment. Operator experience is one of the factors that can affect file separation, and a higher rate of fracture has been reported in procedures performed by inexperienced operators.¹⁻³ The risk of NiTi rotary instrument fracture in the canal has also been shown to be lower when a new instrument is used by an experienced endodontist.⁴

The single-file concept of canal preparation, which uses only 1 file, was introduced by Yared.⁵ Because it uses only 1 file to prepare the entire canal, the single-file system with reciprocating motion has certain advantages over conventional multi-file systems with continuous rotary motion, such as cost-effectiveness and faster root canal instrumentation.⁵⁻⁷ Different single-file canal preparation systems based on this

concept have been introduced to the market. The WaveOne is a reciprocating single-file system introduced by Dentsply Maillefer (Ballaigues, Switzerland) in 2011. There are 3 single-use files available in this system: small (ISO 21 tip and 6% taper), primary (ISO 25 tip and 8% taper), and large (ISO 40 tip and 8% taper). The reciprocating motion is provided by a dedicated motor such that the engaging (counterclockwise) angle is 5 times greater than the disengaging (clockwise) angle. The files are made using M-wire technology, which has been reported to increase the cyclic fatigue threshold by nearly 400% relative to conventional NiTi.⁸

A recent study found an inverse relationship between operator experience and the frequency of file separation with certain NiTi files, even when the files were used repeatedly.⁹ The aim of this study was to assess the influence of operator experience level on the lifespan of the WaveOne Primary file in extracted teeth.

Materials and Methods

Sample size estimation

The necessary sample size was estimated using data gathered in previous trials and experience with the WaveOne Primary file. The primary outcome was the number of canals prepared by each file. We used a standard deviation (SD) of 3.5 and were seeking a mean difference of 5 canals (2-tailed $\alpha = 0.05$ and power = 0.80) between the 2 groups to ensure that the results could be considered statistically different. To meet these criteria, a minimum of 8 files was needed; therefore, 10 files were allocated to each group. The number of canals prepared with each file was recorded for both groups.

Teeth collection

Human mandibular and maxillary molars were collected from among teeth that had been extracted for reasons unrelated to the current study, and were stored in 0.1% thymol solution at 4°C until further use. Access cavities were prepared using Endo Access burs (Dentsply Maillefer). According to the manufacturer's instructions regarding file selection, canals in which movement of #10 stainless steel K-files showed resistance (i.e. suitable for the WaveOne small file) or in which #20 K-files easily reached working length (WL, i.e. suitable for the WaveOne large file) were excluded. To eliminate access variability, the crown of each tooth was sectioned at the cemento-enamel junction before further use. The WL was determined by subtracting 1 mm from the length of a #10 stainless steel K-file that became visible at the apex. With the K-files in place, X-ray images (DenOptix Digital Imaging System, Gendex, Hatfield, PA, USA) were taken in the bucco-oral direction to determine

the canal curvature and radius according to Pruett's method.¹⁰ AutoCAD 2013 (Autodesk Inc., San Rafael, CA, USA) software was used to measure the curvature of the canals. Canals were randomly assigned to one of the 2 experimental groups. Randomization was stratified by the degree and radius of curvature to ensure equal distribution of canals to each group with respect to canal curvature.

Preparation of canals

Canal preparation was performed by 1 experienced operator and 1 inexperienced operator. The experienced operator had worked in the field of endodontics for more than 10 years and had extensive experience with both rotary and reciprocating canal preparation techniques; the inexperienced operator was a recently graduated dentist with no experience in rotary or reciprocating canal preparation techniques.

In both groups, preparation to the full WL was accomplished using WaveOne Primary files with Glyde (Dentsply Maillefer) as the lubricating agent together with a dedicated WaveOne motor. WaveOne Primary files were used with a gentle inward pecking motion, with short 2- to 3-mm amplitude strokes, as recommended by the manufacturer; after every 3 strokes, the files were withdrawn from the canal and cleaned with alcohol gauze to remove debris. Patency of the canal was checked manually with a #10 stainless steel K-file, followed by irrigation with 3% NaOCl irrigant solution.

Instrumentation of each canal was considered complete when the Primary WaveOne file reached the full WL. Additional canals were instrumented with the same file until separation of the file occurred, and the number of canals prepared by each file was recorded. Canals in which file separation occurred were excluded from the preparation counts. A new WaveOne Primary file was used by the same operator to prepare further canals, and 10 WaveOne Primary files were allocated to each group. The length of the fragment was determined using a digital calliper to subtract the length of the fractured file from the standard length of the file. The location of each fragment was determined radiographically.

Statistical analysis

Statistical analysis was done to determine the presence of significant differences in the mean angle and radius of curvature in the root canals distributed between the 2 groups. Analysis was also done to determine if there were any differences in the mean fragment length between the files in both groups. Independent 2-sample *t*-test was used to compare the number of canals prepared between the 2 groups. IBM SPSS Statistics (ver. 20.0) was used to conduct all analyses.

Results

In the experienced group, the mean (SD) of the radius and angle of curvature of the root canals was 11.41 (4.51) mm and 36.49 (13.36) degrees, respectively; in the inexperienced group, the corresponding values were 10.99 (4.79) mm and 34.56 (15.48) degrees, respectively. There were no statistically significant intergroup differences in canal radius and angle of curvature (Table 1).

Table 2 shows the number of canals prepared with each file and the mean (SD) number, total number, and range of canals prepared in both groups. The experienced operator prepared a total of 18 more canals than the inexperienced operator. However, the mean number of canals prepared with each file did not show a significant intergroup difference.

Table 2 also shows the fragment length of each file used by the experienced and inexperienced operators. All separations occurred in the middle or apical third of the canal, with 6 files showing a separation in the apical third and 4 files in the middle third in both groups. In addition, all separated file fragments were within the apical 5 mm of the file. There was no significant difference in the mean fragment length between the 2 groups (4.13 ± 1.04 mm and 4.47 ± 0.56 mm for the experienced and inexperienced operators, respectively).

Discussion

The results of the present study showed no association between the number of canals prepared with one file and operator experience; file separation tended to occur after preparation of a specific number of canals. We considered that the influence of experience was insignificant because, first, the single-file concept requires a shorter learning process than a full-sequence rotary system and, second, the preset reciprocating motion of the system decreases the chance of binding and locking.⁵ We attempted to ensure comparability of both operator groups with regard to the degree and radius of curvature. Further, the crowns of the teeth were sectioned to eliminate access limitation in both groups; in clinical practice, access limitation can subject the instrument to more stress and consequently cause file separation, especially with inexperienced operators.¹¹

Knowledge of canal preparation techniques using a single file without the risk of separation is clinically important, especially for general and inexperienced dentists. Although dentists are showing interest in learning how to use rotary systems, file separation is one of the main reasons why they do not use rotary files.¹² In this study, a minimum of 9 canals was prepared by the inexperienced operator, which suggests that 1 molar tooth or at least 4 canals can be prepared using this system. In

Table 1. The angle and radius of curvature of the canals in the groups treated by the experienced operator and inexperienced operator

	Experienced operator	Inexperienced operator
Angle of curvature (degrees)	36.49 \pm 13.36	34.56 \pm 15.48
Radius of curvature (mm)	11.41 \pm 4.51	10.99 \pm 4.79

There were no differences between two operators within each measurement.

Table 2. Number of prepared canals and fragment length (mm) of the fractured files with respect to operator experience level

Number of canals prepared with Primary WaveOne file (<i>n</i> = 10)				
	Number of canals prepared*	Range of the number of canals prepared	Total number of canals prepared with 10 files	Fragment length of the fractured files (mm)*
Experienced operator	17.1 \pm 3.47	13 - 25	171	4.13 \pm 1.04
Inexperienced operator	15.3 \pm 3.59	9 - 20	153	4.47 \pm 0.56

*There was no statistical difference between experienced and inexperienced operators in the number of canals that could be prepared with one Primary WaveOne file and the fragment length of the fractured files (Independent 2-samples *t*-test).

two studies by Burklein *et al.*^{13,14} in which all the canals were prepared by an experienced operator though the main objective was not investigating file separation, the WaveOne Primary file was used in up to 4 canals with no file separation, which is consistent with our finding. Considering operator experience level with the WaveOne Primary file, Goldberg *et al.*¹⁵ compared shaping ability between students and experienced operators, and reported no difference in centering ability between groups. Their study was performed using simulated root canals and no file separation was reported, except for a small number of untwisted apical flutes in S-shaped canals.

You *et al.*⁷ reported that the reciprocating F2 file could prepare 10.6 canals before separation. We found that, on average, the experienced operator prepared 17.1 canals and the inexperienced operator prepared 15.3 canals using each WaveOne Primary file. The higher number of canals prepared in our study by the WaveOne Primary file is possibly due to its motion, design, and M-wire technology.¹⁶⁻¹⁸ The reciprocating motion prevents the taper lock phenomenon by asymmetrical repetitions of clockwise and counterclockwise rotations.^{5,19} M-wire technology is claimed to increase flexibility and resistance to cyclic fatigue; cyclic fatigue resistance was increased by up to 390% compared with the same instrument design produced from stock 508 nitinol.⁸ These variables could also explain the absence of file separation for at least 4 canal preparations in previous studies of the WaveOne. In our study, all separations occurred in the middle and apical thirds of the canals, and file fragments were less than 5 mm in length. This coincides with the progressive decrease in taper of WaveOne Primary files after D4. Because both stresses, cyclic fatigue and torsional stress, occur simultaneously in the clinical situation, detailed fractography of the fragments is required to gain insight into the mechanisms of failure of the files.²⁰

This study had the following limitations. First, there was only 1 operator in each group, which might not have been representative of the experienced and inexperienced clinicians. Second, variables in canal preparation, such as shaping ability and canal aberration, that can affect clinical success with this file depending on the level of experience were not considered in this study. However, WaveOne Primary files showed considerably long lifespan in natural teeth by both operators which can raise expectations that the files can be used for more than once without an increased risk of separation. Long lifespan of WaveOne Primary would also reduce operator's concern about file separation, and it would encourage clinicians to study and use new root canal preparation techniques.

Conclusions

Under the conditions of this study, operator experience

appeared to have no effect on lifespan of WaveOne Primary files in preparation of moderately curved canals. Single teeth with multiple canals can be prepared safely even by a novice operator using this single file. Further studies are needed to evaluate the stresses induced on the root structures from single-file canal preparation, as well as the shaping ability and cleaning effectiveness of these files.

Conflict of Interest: No potential conflict of interest relevant to this article was reported.

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