Original Article

Does The Working Length Change When Using The XP-Endo Shaper File at Different Operating Temperatures?

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Received 8 April 2021 and Accepted 18 May 2021

Abstract

Introduction: This study was directed to evaluate the effect of different operating temperatures on the change in working length when using the XP-endo shaper file. **Methods:** A total of 20 plastic blocks with16 mm curved canals were used in this study. The working length was adjusted to be 15 mm using a customized Teflon stopper (10mm in length) which was used with all files in the study. The preparation was done using the XP-endo shaper file (FKG, La Chaux-de-Fonds, Switzerland) according to the manufacturer's instructions. The blocks were divided into 2 groups: Group 1: body temperature, Group 2: room temperature. Pre and post instrumentation imaging of the blocks was done using the stereomicroscopy at 8x. The images were superimposed to create a composite image on which the evaluation of working length change was done. Mann-Whitney U test was used to compare the change in working length in the two groups. **Results:** There was no statistically significant difference between the two groups ($P \leq 0.05$). **Conclusions:** Within the parameters of this study, although both groups showed an increase in working length when using the XP-endo shaper file, the operating temperature did not have an effect.

Keywords: Root canal preparation; Rotary files; Working length change; XP-endo shaper.

Elsadat MM, Refai AS, Islam TM. Does The Working Length Change When Using The XP-Endo Shaper File at Different Operating Temperatures? J Dent Mater Tech 2021; 10(2): 108-113.

Introduction

The main aim of root canal preparation is the cleaning and the shaping of the root canal system effectively while preserving the shape and position of the main root canal anatomy (1). The evidence indicates that no matter what rotary Ni-Ti files are used to prepare canals, there will always be a percentage of untouched canal walls (2, 3). This fact was a catalyst for the development of adaptive instruments that better conform to the internal anatomy of the root canal (4, 5). In 2016, the XP-endo shaper file (FKG, La Chaux-de-Fonds, Switzerland) was introduced into the dental market. The manufacturer claims it is made of MaxWire alloy with a tip diameter #30 and a core taper of 1% taper (6). The alloy has an unusual transition temperature which according to the manufacturer, allows the file to expand when it is subjected to body temperature and this expansion appears in the form of a "snake-like" shape (7-9).

Not only accurate working length measurement is crucial for the success of the root canal treatment procedure (10, 11) but also, its maintenance during canal preparation is vital to prevent errors like over or under-extension (12, 13). Several studies have shown that change in working length may occur during instrumentation with Ni-Ti instruments (14-17). These studies differ in the instruments being used and the mechanism of measurement but there is consensus that the change in working length may occur (18).

Furthermore, Webber et. al, evaluated the XP-endo shaper file operated at different speeds using a stereomicroscope. They reported that up to 95% of the XP-endo shaper files evaluated exhibited a degree of straightening or distortion (19). These results shed doubt on the ability of the file to maintain its vertical form

during instrumentation and ultimately may affect working length.

To date, very little research has been done on the XP-endo shaper file regarding the maintenance of working length. Additionally, measuring the working length is usually done at room temperature in which the file is in the martensitic phase while during operation, according to the manufacturer, the shape changes "expand" inside the canal which may also potentially alter the working length. This research was directed to evaluate the effect of the change on the working length when using the XP-endo shaper file at different operating temperatures. The Null hypothesis was that the working length would not be affected by the change in operating temperature.

Materials and Methods

Sample preparation

A total of 20 plastic blocks (Endo Training Bloc; Dentsply Sirona, North Carolina, USA) with curved canals (45˚) with a length of 16mm, the initial size of #15, and 2% taper were used in this study. A specially designed Teflon stopper (10 mm in thickness and 5mm in diameter) was constructed to standardize the working length to be 15mm for all the files.

The sample size calculation was done based on a pilot study conducted on six samples (*n=3*); the mean (SD) values were 0.621 (0.016) mm and 0.528 (0.091) mm for group 1 and group 2, respectively. The effect size (d) = 1.42. Using alpha (α) level of (5%), and power of 80%; the minimum estimated sample size was 9 specimens per group. So, for convenience 10 plastic blocks per group were used. Sample size calculation was performed using G*Power version 3.1.9.2 (Franz Faul, University of Kiel, Germany).

All the canals were prepared using the XP-endo shaper file at 800 rpm and 1Ncm torque using X-Smart endo motor (Dentsply Sirona, North Carolina, USA) according to the manufacturer's instruction. The blocks were grouped according to the ambient temperature during preparation into 2 groups (*n=10*): Group1**:** body temperature (37℃), while Group 2: at room temperature (24℃), both were done using a water bath.

Initially, the glide path was established using a #15 K-file to the working length. For all groups, the XP-endo shaper file was used to prepare the canal using an in-and-out motion. The canal was prepared in 2 phases:

Phase 1: preparation of the canal till the file reached the working length for the first time using 10 strokes.

Phase 2: additional preparation of the canal for another 15 strokes to the working length.

A new XP-endo shaper file was used for each canal and discarded after use. All instrumentation was performed by a single endodontist. After every 5 strokes, the file was removed, cleaned, and recapitulation with #15 K-file to the length was done. Then irrigation with 3ml of distilled water was accomplished using a 30-gauge side-vented needle.

Imaging

Pre and post instrumentation imaging of the blocks was done using a stereomicroscope (Leica EZ4 HD; Leica Microsystems co. Schweiz, Switzerland) at 8x using a customized platform made of polyacrylic resin to ensure the 3D spatial position of the blocks.

Prior to instrumentation, two preoperative images of each block were taken. The first, after placement of a size #15 k-file with the customized stopper attached inserted into the canal (Pr1) (Figure 1) and the second, after injecting a blue dye into the canal (Pr2). After instrumentation, each block was injected with a red dye, and a postoperative image was taken (PO). A ruler was included in each image as a size reference. The Pr2 and PO images were superimposed using Adobe Photoshop CC 2018 (Adobe Systems Inc, CA, USA) to form the composite image (Figure 1 & 2). Then all images were imported into the Autodesk AutoCAD 2019 software (Autodesk Inc., CA, USA) for evaluation.

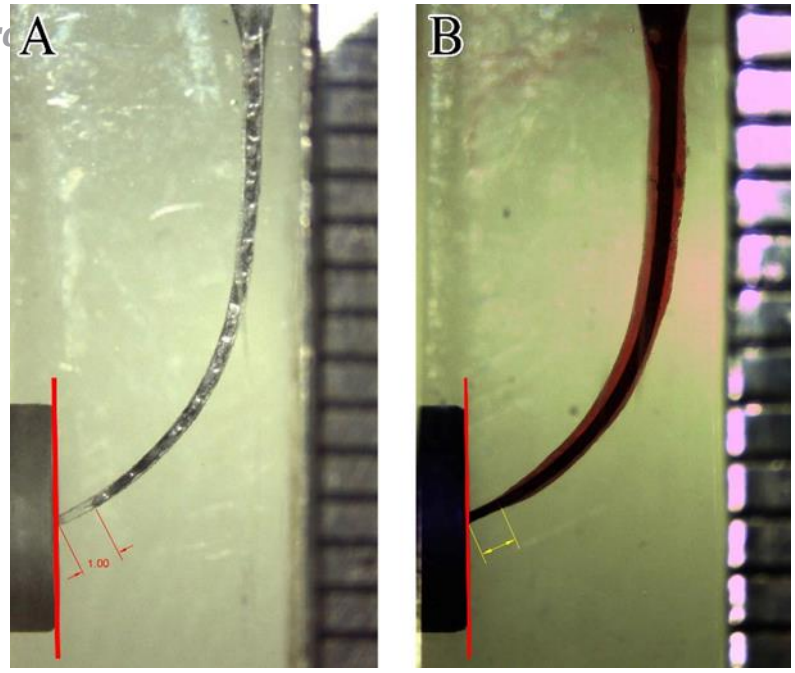

Figure 1: A stereomicroscope image showing: A) preoperative image with file #15 (Pr1). B) The final Composite image (PO and Pr2). The yellow arrow indicates the postoperative distance.

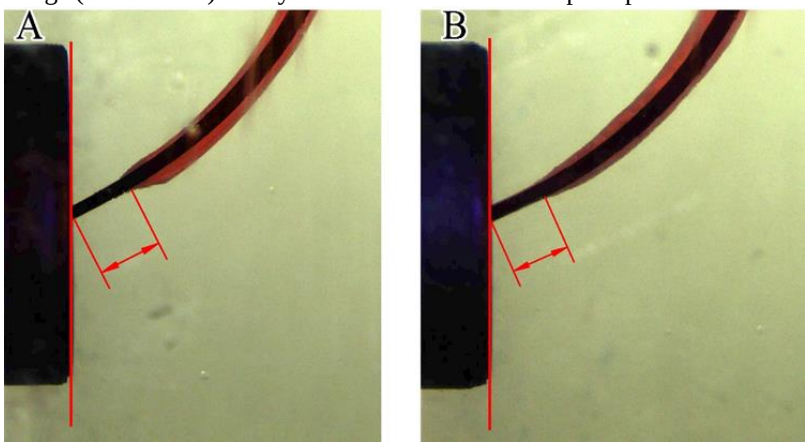

Figure 2: A magnified stereomicroscope image of the apical part of the canal showing: A) sample from group 1, B) sample from group 2. The red arrows represent the remaining untouched canals.

Evaluation of the change in working length

In this study, the change in working length was evaluated by measuring the change in the distance between the terminus of the apical preparation and the end of the block before and after instrumentation.

To accomplish this, the preoperative distance was established by measuring the distance from the end of the file to the end of the block in the Pr1 image. While the postoperative distance was measured on the composite image. The distance of the point of deviation of postoperative canal preparation from the preoperative canal was considered the postoperative terminus of the preparation. Then the postoperative distance was established by measuring from this terminus to the end of the block. Then the change in length was calculated by subtracting the pre-operative distance from the postoperative one.

Statistical analysis of the data

Mann-Whitney U test was used to compare the change in working length in the two groups. The significance level was set at $P \leq 0.05$. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp., Armonk, NY, USA).

Results

Change in working length (mm)

The median, range, mean and standard deviation (SD) were represented in (Table I).

Table I: Descriptive statistics and results of Mann-Whitney U test for comparison between changes in working length (mm) in the two groups:

	Median (range)	Mean±SD	P-value
Group 1 (Body temperature)	0.49 (0.17 – 0.63)	0.44 ±0.19	0.791
Group 2 (Room temperature)	0.44 (0.18 – 0.8)	0.46 ±0.2	

Mann-Whitney U test revealed that there was no statistically significant difference between the median changes in working length in the two groups ($P \leq 0.05$).

Discussion

The maintenance of the working length during root canal treatment is paramount to success. Rotary Ni-Ti files are routinely used during preparation. A new generation of atypical files with irregular shapes is beginning to emerge in the dental market. These files are designed to increase contact with the canal walls during preparation (8). An example of these files is the XP-endo shaper file which is a snake-like shaped file made of modified Ni-Ti alloy (MaxWire) that changes its initial form due to an increase of the temperature around the file once it is inserted into the canal (4, 9). Due to this change, there is a possibility that this file may not maintain the working length during instrumentation. This study was conducted to evaluate the change in working length when using the XP-endo shaper file at two different operating temperatures.

The results showed there was no statistically significant difference in change in the working length between the two operating temperature groups (*0.44 ±0.19* and *0.46 ±0.2* mm) for group 1 (body temperature) and group 2 (room temperature) respectively. Consequently, the null hypothesis was accepted. The rationale for comparing the two temperatures was that working length measurement is done at room temperature, yet the file is inserted into the canal and operates at body temperature.

The plastic blocks used in this study have a higher thermal diffusivity than dentin that ensures that the file will have changed into the Austenitic form during the preparation.

Furthermore, it is noteworthy to mention that both groups showed an increase in working length which is clinically relevant. Although the manufacturer claims that the file can expand beyond its core size due to a phase transformation from Martensite to Austenite space lattice, yet this did not result in a significant change in working length in this study. This can be explained by the fact that the XP-endo shaper file is still limited to the confines of the narrow canals in which it is placed. This limitation may have prevented the change in phase to translate into a change in working length.

Within the search parameters of this research, no studies have been done which directly evaluate the change in working length of the XP-endo shaper file. Alternatively, a lot of studies on the XP-endo shaper have been focused on the evaluation of shaping ability (20-24). One research in particular done by Azim et al, (4) corroborates the results of this study. The researchers evaluated the shaping ability of the XP-endo shaper file in oval canals using µCT. In their study, they observed that debris packed in the apical area, and concluded that the XP-endo shaper file did not expand in the coronoapical direction but only expands in the mesiodistal and buccolingual directions. Moreover, their study was conducted on oval canals while in this study, plastic blocks with narrow canals with the initial size of #15 were used. This confirms that the change in working length may have been due to the file being confined in a narrow canal.

Conclusion

Although within the parameters of this study the operating temperature did not affect the working length, yet all the specimens showed a degree of overextension. This overextension could affect the outcome of conventional root canal treatment. Care should be taken when transferring the results of this study into the clinical settings. Further research should be done to evaluate the change in working length using the XP-endo shaper file in canals with varied sizes and anatomical configurations.

Acknowledgement

The authors deny any conflicts of interest related to this study.

Conflict of interest

The authors deny any conflicts of interest related to this study.

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