Accuracy of the Root ZX II using stainless-steel and nickel-titanium files

Emmanuel João Nogueira Leal da **SILVA**[1]
Daniel Rodrigo **HERRERA**[2]
Carolina Carvalho de Oliveira **SANTOS**[3]
Brenda P. F. A. **GOMES**[4]
Alexandre Augusto **ZAIA**[5]

ABSTRACT

Objective: The aim of this *in vitro* study was to evaluate the accuracy of the Root ZX II electronic apex locator (EAL) using hand stainless-steel file, nickel-titanium hand file and nickel-titanium rotary file. **Methods:** Twenty straight single-rooted maxillary central teeth were used. The actual working length (AWL) was measured by inserting a #15 K-file until the file tip was visible at 4x magnification. The file was removed from the canal and its length was measured using a digital caliper. For the electronic measurements, samples were fixed in glass recipients with plastic cover, containing 0.9% saline solution. The measurements were carried out using the Root ZX II and they were performed using a #15 K-file, NiTi hand file and a rotary Mtwo file. The files were attached to the EAL and during their insertion into the root canal the measurements were monitored until the display indicated "zero". The corresponding values of the difference between the AWL and the electronic measurement were recorded and submitted to ANOVA and Tukey test (α=0.05). **Results:** No statistically significant differences ($p<0.05$) was found among the tested files. **Conclusion:** It can be concluded that both stainless steel files and NiTi hand or rotary files are adequate to determine the working length using the Root ZX II.

Keywords: Tooth apex. Dental instruments. Endodontics.

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[1]MSc in Dental Clinic, Unicamp. Doctorate student in Dental Clinic, Unicamp.

[2]MSc in Health Sciences, UEMC. Doctorate student in Dental Clinic, Unicamp.

[3]MSc in Health Sciences, UEMC. Doctorate student in Dental Clinic, Unicamp.

[4]MSc in Endodontics, UFRJ. PhD in Restorative Dentistry, University Dental Hospital of Manchester. Post-Doctorate, Ohio State University. Full Professor, Unicamp. Professor of Endodontics, FOP - Unicamp.

[5]MSc in Biology and Buccodental Pathology, Unicamp. PhD in Biology and Buccodental Pathology, Unicamp. Post Doctorate, University of Minnesota. Full Professor, Unicamp. Endodontics Professor, FOP - Unicamp.

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Contact address: Emmanuel João Nogueira Leal da Silva
Rua Herotides de Oliveira, 61-902 – Icaraí – 24.230-230 – Niterói/RJ – Brazil
E-mail: nogueiraemmanuel@hotmail.com

Introduction

Determining the working length (WL) correctly is an important step in the root canal treatment, ensuring that biomechanical preparation and filling materials be restricted to the canal space and avoiding, thus, harm to both periradicular tissues.[1] The WL is defined as the distance from a coronal reference point to the one in which the canal preparation and obturation should terminate.[2] Underestimation of the WL can lead to insufficient debridement of the root canal, whereas overestimation can result in damage to the periapical tissue, which will delay or prevent healing.[3,4]

Recently, electronic methods for determining the WL have become common in endodontic clinics. Several studies have demonstrated the high efficiency of electronic apex locators (EAL) as well as their ability to determine the WL even in adverse situations such as the presence of irrigation agents, blood and large foramen.[1,5,6] In addition, the radiographic method for determining the WL has limitations that include image distortion,[7] overlapping roots and anatomical structures, as well as exposure to higher radiation.[8]

Recent advances in endodontics include instruments made of nickel-titanium (NiTi). NiTi has some advantages such as improved apical third debridement for its greater flexibility[9], shorter operative time[10], as well as greater fracture resistance.[11] Thus, the objective of this study was to evaluate the accuracy of Root ZX II in permanent teeth using stainless steel files, NiTi hand files and NiTi rotary files.

Materials and Methods

Twenty straight single-rooted maxillary central teeth were used. Roots with resorption, fractures or open apices were excluded from the study. Canal patency was evaluated using a K #10 file (Dentsply-Malleifer, Ballaigues-Suíça). The cusps were flattened to establish an equal root length and a stable and reproducible reference point for all measurements. Pulp chambers and canal were cleaned by irrigating with 5 ml of 5.25% sodium hypochlorite.

The actual working length (AWL) was measured by inserting a K #15 file (Dentsply-Malleifer, Ballaigues-Suíça) until the file tip was just visible at using 4x magnification. After adjusting silicone stop to the coronal reference, the file was removed from the canal and its length was measured using a digital paquimeter with an accuracy of 0.01 mm.

For the EAL measurements, samples were fixed in glass with a plastic cover, containing 0.9% saline solution. Two holes were made in the plastic cover: In the first, the lip clip was placed in contact with the saline solution and in the second in which the root was adapted with the assistance of the utility wax, when it was needed, the root was in contact with the saline solution, instead. The measurements were carried out using the Root ZX II (J Morita, Kyoto, Japan).

It was performed using a K #15 file (Dentsply-Malleifer, Ballaigues-Suíça), NiTi hand file #15/0.02 (Dentsply-Malleifer, Ballaigues-Suíça) and a rotary Mtwo #15/0.05 file (VDW, Munich, Germany) in rotary motion using a VDW silver motor (VDW, Munich, Germany). The files were attached to the EAL and during their insertion into the root canal, the measurements were monitored on the EAL display until it indicated "zero". The measurement was considered valid if it remained stable for at least 5 seconds. After, the stops were set in the coronal surface, measurements were taken with a digital paquimeter and compared with the AWL obtained earlier. All measurements were made by the same operator. The corresponding values to the difference between the AWL and the electronic measurement (EWL) were recorded and submitted to Analysis of Variance (ANOVA) and subsequently to the Tukey test with a significance level of 5%. Statistical analysis was performed using SPSS software (LEAD Technologies, Chicago, USA).

Results

For each canal the difference between AWL and EWL were calculated. The means values of the difference between AWL and EWL and their standard deviations are shown in Table 1. The reliability rate (tolerance of 0.5 and 1 mm) of WL is presented in Table 2.

No statistically significant difference ($p<0.05$) were found among the tested files.

Discussion

Numerous *in vitro* and *in vivo* studies have reported the accuracy of EALs in determining the correct WL.[1,5,6,10,12] Although the absence of periodontal ligament is one of the inconveniences of the *in vitro*

studies, it can be compensated using 0.9% saline solution. Saline solution is an excellent way to establish sufficient electrical circuit for the correct operation of LAEs as it has similar impedance properties as the periodontal ligament.[14] This model was used successfully in several studies[1,13,14] as well as in ours.

The possibility of doing rotary instrumentation with EAL coupled in the instrument opens a new perspective regarding the control of apical extension of instrumentation. It also makes the root canal treatment easier and faster, optimizing the endodontist work.

In the present study, there was no significant difference among the tested files groups, showing a high accuracy to determinate WL. These results are consistent with previous study that showed no difference between stainless steel files and NiTi hand files[15]. Contrary to these results, Siu et al,[16] achieved *in vivo* greater accuracy using hand files when compared with NiTi rotary files, probably due to a better movement control of the hand files. In the present study the measurement was also performed with rotational movements and no difference was found between hand and rotary files. Such results can be justified by the use of different methodologies to determine the WL and to assess the accuracy of the same.

Among the samples, only one in the hand steel file and in hand NiTi file group showed a difference of the AWL and the EWL greater than 1 mm. The majority of the measurements stayed between 0.01 and 1 mm from the apex. A 1 mm tolerance can be considered clinically acceptable.[1,3,10,13,14] Using this measurement criterion there was a high precision of all tested files showing 95% accuracy in NiTi hand files and stainless steel file and 100% in rotary NiTi files. Similar results were also found by other authors who obtained similar accuracy rate of LAEs location of fractures and perforations.[17,18]

Table 1. Mean difference between AWL and EWL (mm).

File	Size	Mean±SD (mm)
K files	15/0,02	0,483 ± 0,31[A]
NiTi hand file	15/0,02	0,436 ± 0,30[A]
NiTi rotary file	15/0,04	0,372 ± 0,25[A]

Same letters show no statistically significant difference

Table 2. Reability rate using different files.

Distance from AWL (mm)	K File n (%)	NiTi hand file n (%)	NiTi Rotary file n (%)
> 1	1 (5%)	1 (5%)	0 (0)
0,50 a 1	8 (40%)	6 (30%)	5 (25%)
0,01 a 0,50	11 (55%)	13 (65%)	15 (75%)
0	0 (0)	0 (0)	0 (0)

Conclusions

With the limitations of the present work, it can be concluded that both stainless steel files and NiTi hand or rotary files are suitable for determining the working length using the Root ZX II.

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