

Working Length Determination by Two Apex Locators: An In Vivo Study

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ABSTRACT

Introduction: The endodontic success depends on the complete removal of all pulp tissue, necrotic material and microorganisms from the root canals. Several devices for measuring the root canal length have been developed and tested. The use of electronic apex locators for working length determination eliminates many of the problems associated with the radiographic measurements.

Objective: To test the accuracy of two new apex locators Propex mini and Root ZX mini in determining working length.

Materials and Method: Thirty-two single-rooted teeth were selected from the patients who were scheduled for extractions. Access cavities were prepared and pulp was extirpated. Both the electronic apex locators were used to measure the working length and the values noted. With the aid of the stereomicroscope (20X) the distance between the tip of each file and the apical foramen of each specimen was analysed. Negative and positive values were attributed to measurements that were short and beyond the apical foramen, respectively.

Result: No significant statistical difference was found between actual length of the canal and the length measured by Root ZX mini whereas there was significant difference between actual length of the canal and canal length measured by Propex mini electronic apex locator. A cent percent accuracy was seen with Root ZX mini within the range of 0.5 mm whereas 96.9% accuracy was seen with Propex mini apex locator.

Conclusion: Electronic apex locator Root ZX mini and Propex mini can accurately determine the working length however, Root ZX mini showed better accuracy.

Keywords: Electronic apex locator; propex mini; root zx mini; working length.

INTRODUCTION

The endodontic success depends on the complete removal of all pulp tissue, necrotic material and microorganisms from the root canal. This can only be achieved if the length of the root canal is determined with accuracy.¹ Root canal treatment should be limited to within the root canal system,² thus, the endpoint of the root canal system and the

canal terminus, should be detected as precisely as possible.³

Traditional methods for establishing working such as tactile method, paper points method or radiographic methods are not accurate.⁴ Although radiographic method has been widely used for working length determination, the exact identification of the position of the apical constriction with radiograph

is difficult to achieve and causes error in detection due to its two dimensional nature.⁵⁻⁷

With the introduction of electronic apex locators (EALs), many of such problems have been eliminated.⁸ Recently, the manufacturers of Root ZX (J Morita, Tokyo, Japan), and Propex (Dentsply-Maillefer, Ballaigues, Switzerland), launched Root ZX Mini and Propex Mini which have claimed to be giving accurate measurements in determining working length.⁹

Thus, the aim of present study was to compare the accuracy of Propex mini and Root ZX mini, in vivo, for determining the location of apical foramen.

MATERIALS AND METHOD

This cross-sectional in vivo study was conducted in the Conservative Dentistry and Endodontics Unit, Dental Department of Bir Hospital from August 2017 to Sept 2018. Thirty-two single rooted (Type-1) permanent teeth from patients, aged 18 to 60 years, which was scheduled for extraction, due to orthodontic, prosthodontic or periodontal reasons, were taken for the study using convenience sampling technique. Sample size was calculated as 32 using the formula $N=Z^2\sigma^2/d^2$ assuming the dispersion of 0.29 mm to estimate the mean distance from the tip of the instrument to the apical foramen and assuming the tolerable error of 0.1 mm on each side of the mean.

Previously endodontically untreated teeth were included and confirmed by taking preoperative radiographs. Fractured teeth, calcified teeth, deciduous teeth, open apex, internal and external resorption and teeth with anatomical aberrations were excluded from the study. Ethical approval was taken from the institutional review board and verbal and written consent were taken from all the patients before the procedure. All clinical procedures and measurements were carried out by principal investigator (RJP). Before the procedure, intraoral periapical radiographs were taken for the teeth indicated for extraction. The teeth were then anaesthetised with 2% lignocaine with adrenaline 1:80000 (Scandicaine 2%; Septodont, Saint-Marddes-Fosses, France) and isolated with a rubber dam. Access cavity was prepared using endodontic access cavity kit (Dentsply-Maillefer). Coronally, flat surface was created to provide stable reference

points for the measurements. The pulp chamber was accessed with a 701 or 702 tapered fissure bur or straight fissure bur (Mani Inc.) in a contra angle air rotor handpiece with coolant (NSK). The roof of the pulp chamber was removed with No. 2 or 4 round burs (Mani Inc.) running at slow speed in contra angle micro motor handpiece (NSK). The canal orifice was located by an endodontic explorer (DG 16, Hu-Friedy). Any residual pulp tissue was removed from the root canals with a barbed broach (Mani Inc.) or HeadStrom file (Mani Inc.).

Canals were pre-flared with rotary Protaper SX (Dentsply-Maillefer) attached to X-smart endomotor (Dentsply-Maillefer) and smooth glide path was prepared with 10 and 15 number K-files. Then, the canal was instrumented with rotary S1 ProTaper file (Dentsply-Maillefer). Canal was irrigated during the chemo-mechanical preparation with 3% sodium hypochlorite. Electronic measurement was conducted using hand K-files (Dentsply-Maillefer) fitted to the anatomical diameter of each canal. The largest file was inserted until its tip reached the apex indicated in the devices. The measurements were performed with both EALs in all teeth. The first apex locator to be used was randomly selected and their use was then alternated. Both the devices were operated according to the manufacturers' instructions: after positioning the lip clip, the electrode was attached to the file and inserted in the canal. The file was then advanced into the canal until the EAL screen displayed the word "APEX" (in Root ZX-mini) or "APEX" simultaneously with "0.0" (in Propex-mini). The rubber stop was then positioned on the occlusal reference, and a new measurement was made, with special care to avoid shifting the file. The distance between the tip of the file and the stop was measured with a digital caliper. Measurements were recorded and the procedures were repeated with the other EAL, using the same file. Next, the file was re-inserted in the canal, up to the measurement indicated by the last device and fixed in this position with a composite restorative material. After the adhesive were set, the canal length measurements were confirmed, the rubber dam was removed, and the tooth was extracted. In order to expose the canal, the apical 4.0 mm of each root was grounded from buccal to lingual, under magnification. To prevent disruption of the file, the apical part of the tooth was carved with a scalpel. With the aid of the stereomicroscope (20X) (Model

SZ2-ILST, OLYMPUS CORP, TOKYO) each specimen was analysed for the distance between the tip of each file and the apical foramen (Figure 1). Negative and positive values were attributed to measurements that were short and beyond the apical foramen, respectively. In order to prevent biased interpretation, the most coronal border of the major foramen was used as an anatomical reference for this evaluation. The difference in length (mm) between the file that were fixed (measurement with the last EAL) and the first file used (first EAL) were also calculated for each canal.

Measurements were collected in the data sheet and statistical analysis was done using SPSS Statistics for Windows, version 16.0 (SPSS Inc., Chicago, Ill., USA).

RESULT

There was minimal difference in two apex locators but the mean of paired comparison was significantly different for two lengths (Table 1). The length measured by Propex mini and length measured by stereomicroscope were compared and the mean value of paired comparison was significantly different for two lengths (Table 2). When comparing the mean and standard deviation value measured by Root ZX mini with length measured by stereomicroscope it was found that the mean of paired comparison was not significantly different for two lengths (Table 3). Number of teeth length difference of Propex mini as seen through stereomicroscope is shown in Table 4. Number of teeth length difference of Root ZX mini as seen through stereomicroscope is shown in Table 5.

Table 1: Paired t-test comparison of root length using different apex locators.

	Mean±SD	T-test	P value
Length using Propex-mini	19.67±2.69	2.49	0.018
Length using Root ZX- mini	19.55±2.64 20		

Table 2: Root lengths using propex-mini and stereomicroscope.

	Mean±SD	T-test	P value
Length using Propex-mini	19.67±2.69	3.232	0.003
Length using stereomicroscope	19.50±2.69		

Table 3: Root lengths using root-zx mini and stereomicroscope.

	Mean±SD	T-test	P value
Length using Root ZX- mini	19.55±2.64	1.139	0.263
Length using stereomicroscope	19.50±2.69		

Table 4: Working length difference of propex-mini as seen through stereomicroscope.

WL difference in mm	n (%)	Total percent (%)
0	20 (62.5)	96.9
0.5	11 (34.4)	
1	1 (3.1)	3.1
Total	32 (100)	100

From 0 to 0.5mm length, total of 96.9 % coincide, whereas 1mm over is 3.1%.

Table 5: Working length difference of root-zx mini as seen through stereoscope.

WL difference in mm	n (%)
0	25 (78.1)
0.5	7 (21.9)
Total	32 (100)

From 0 to 0.5mm length, 100% coincide.



Figure 1: Procedural photographs in a patient, taken by stereomicroscope and stereomicroscope.

DISCUSSION

Clinically, determination of working length for root canal preparation and obturation plays a vital role

in the success of endodontics. It is usually placed at or short of apical constriction¹⁰ and generally lies 0.5 to 0.8 mm from the major diameter or apical foramen. Martinez-Lozano et al. in their study,

concluded that the Apit EM-S³ apex locator locate the position of the file on the apical foramen as the apex as it advanced in the root canal which produced measurements that are more accurate.¹¹ In this sense, considering the apical foramen to be an appropriate reference, as it was easily visualised under the microscope, will be more accurate.

In the present study, the apical constriction was not used as a landmark because it was impossible to determine its location in most samples, whereas the major foramen could be located consistently. As a consequence, in this study, the actual working length was established to be 0.5 mm coronal to the major foramen, as suggested previously by various authors.¹²

Comparison was made with the measurement of EAL when it indicated the apex (major apical foramen) and illuminated the 00 in display meter. In the present study, fine files were introduced to prevent the violation of the minor apical constriction. Meredith et al. supported the reason behind using fine file with gentle handling to minimise the disruption of canal wall and prevent any changes in anatomy due to instrumentation.¹³

There have been very limited studies and documentation related to the vivo studies of different apex locators. Grimberg et al. evaluated the clinical performance of Tri Auto ZX and reported that Tri Auto ZX was a reliable tool, and EAL measurements were coincident or within 0.5 mm from the actual length. Welk et al. compared two frequency-based EALs (Root ZX and EndoAnalyzer Model 8005) and reported that the use of EALs is a reliable method for determining root canal length.¹⁴

In this study, comparing both the EALs, the mean of paired comparison of Propex mini and Root ZX mini is significantly different for two EALs whereas the individual comparison of length of Propex mini with working length of stereomicroscope are significantly different with each other with the P value of 0.003.

In the same way, the individual comparison of working length of Root ZX mini with that of stereomicroscope were not significantly different with each other with the P value of 0.26.

Some other in vivo studies that used the Root ZX have produced results that, in general, are in agreement with our results despite the fact that some of them measured the distance to the apical constriction which could not be located predictably.¹² In their study, the mean distance from the actual working length to the file tip was 0.14 mm for the Root ZX and 0.12 mm for the iPex.¹² Statistical analysis showed no significant differences between the two EALs whereas in this study the mean value shown by Propex mini is significantly different with stereomicroscope.

When the frequency of the sample that had same length compared with stereomicroscope, in case of Root ZX were 78.1% in 00 mm that is 25 samples similarly 0.5 mm difference in seven samples. Many of the studies used an error range of ± 0.5 mm to assess the accuracy of the EALs.¹⁴ Measurements attained within this tolerance ± 0.5 mm were considered highly accurate.¹⁵ Thus, in the present study Root ZX mini gave the 100% sample within the range of ± 0.5 mm whereas the Propex mini shows 20 samples coincide the working length in 00 mm, and 11 samples in 0.5 mm, and one sample gone 1 mm beyond, which gave the accuracy of this apex locator from 0 mm to 0.5 mm were 96.9%.

Present study results were correlated with the findings of the other studies, who observed EALs working length accuracy percentages ranging from 60% to 100%, depending on the tolerance margin, and mean error values near 0.0 mm.⁹ Thus, these values mentioned in this study certify the efficiency of the Root ZX mini measurement approach, may be considered a strongly reliable method whereas Propex mini showed the equally good results which we can consider as the effective method of working length determination.

Although the research has reached its aims, there were some unavoidable limitations. We could have done this study in large sample size and with many other apex locators.

CONCLUSION

In the light of the finding of the study the following conclusions are made: i) use of electronic apex locator is reliable tool for measuring the working

length; and ii) both Propex mini and Root ZX mini apex locators give satisfactory result but Root ZX mini provides better results.

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Conflict of Interest: None.

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