

# Accuracy of Different Apex Locaters. (A Comparative in Vitro Study)

Mohammad Munthir Abdulrazzaq<sup>1</sup>, Emad Farhan Alkhalidi<sup>2</sup>

<sup>1</sup>Lecturer Dr. PhD, Conservative Dentistry/ Al-Iraqia University Collage of Dentistry/ Department of Conservative Dentistry, <sup>2</sup>Assistant Professor, Dr.PhD Conservative Dentistry / University of Mosul/ Collage of Dentistry/ Department of conservative Dentistry/Iraq

## Abstract

**Aims:** The objective of this in vitro study was to compare the accuracy of the Root-ZX II, Root ZX Mini, i Pex II, Kerr apex ID, Root PI and YD2 electronic apex locaters (EALs) in locating the apical foramen.

**Materials and Methods:** Fifty extracted human teeth with mature apices were used. Access cavities were prepared. In order to make sure that we have an accurate working length of 21 mm the crown was sectioned with diamond disc (control). The teeth were then embedded in an alginate model to simulate the periodontium after that the Canals were irrigated with 2.5% sodium hypochlorite. The actual length and electronic length measurements were made on each specimen separately by apex locator devices with an aid of a K-type file.

**Results:** Statistical results showed no significant difference between the 6 devices although concerning locating the apical foramen, Root-ZXII, Root ZX Mini, were accurate 96% of the time to  $\pm 0.5$ mm, where as I pex II and Kerr apex ID were accurate 94% of the time to 0.5 mm from the apical foramen, 44%  $\pm 0.5$ mm for the Root PI and 44%  $\pm 0.5$ mm for the yD2. **Conclusions:** All the apex locaters were able to determined the position of the apical foramen but consequently the Root-ZX II, Root ZX Mini, i Pex II, Kerr apex ID were more accurate than Root PI and YD2 apex locaters.

**Key word:** Apex Locator, Root-ZX II, Root ZX Mini, i Pex II, Kerr apex ID, Root PI apex locator and YD2 apex locator.

## Introduction

The determination of an accurate working length is one of the most critical steps of endodontic therapy. The cleaning, shaping, and obturation of the root canal system cannot be accomplished accurately unless the working length is determined precisely. Most operators attempt to terminate instrumentation 0.5-1mm short of the radiographic apex. Although radiography is the most commonly used diagnostic aid in endodontics, clinically root morphology and radiographic distortion may cause the location of the radiographic apex to vary from the anatomic apex which could lead to over or under filling<sup>(1)</sup>. Furthermore, radiographic interpretation of the apices of some teeth (e.g. maxillary molars) may be so difficult that radiographic working length determination is not accurate<sup>(2)</sup>.

Recently, electronic methods for tooth length determination have gained popularity. The latest generation of apex locaters has many advantages when compared to earlier devices. Unfortunately, many devices are inaccurate in root canals that contain moisture, vital pulp tissue, blood, and other exudates<sup>(3)</sup>.

On the other hand many studies report on the accuracy achieved by the new generation of electronic apex locaters as well as their extended measurement capabilities, which include accurate measurements in the presence of electrolytes<sup>(4)</sup>.

Many types of EALs were manufactured but most studies on electronic apex locaters using two frequencies (the third generation) report accuracy rates of 85–95%<sup>(5)</sup>.

The objectives of the present study were to test the accuracy of six types of apex locators in an in vitro model and to compare its accuracy to the actual working length.

### Materials and Methods

This study was approved by Research Ethics Committee at College of dentistry, University of Mosul (Approval number UoM.Den/H.L.34/21).

The research involved 50, extracted, single-rooted, human lower premolar teeth with mature apices, preserved in Thymol solution and kept refrigerated.

In order to make sure that we have an accurate working length of 21 mm the crown was sectioned with diamond disc to a level so that all the teeth have a constant working length of about 21 mm (control) and establish a level surface to serve as a stable reference for all measurements and also for statistical purposes.

The access cavities were prepared (Diamond burs, 10541M, Technical & General Ltd). The actual root canal length is the distance from the coronal reference point to the apical foramen. It was measured by inserting a #20 file into the root canal until the file tip was just visible at the level of the apical foramen this procedure was done under a stereo microscope (Heerbrugg, Switzerland) at

this point the stopper adjusted to the coronal reference point. This procedure was done to make sure that all the teeth have constant working length of about 21mm.

Each measurement was repeated three times and if there was a difference in the measurements from the 21mm the working length of the tooth was adjusted to be 21mm.

Teeth were then embedded in an alginate model to simulate the periodontium specially developed to test apex locators <sup>(6)</sup>. The alginate (Kromopan Lascod, Italy)) was poured into the mold then each tooth was embedded into the alginate and kept in position until the alginate had set completely. The model was used immediately so that to keep it humid and when not in use; it was wrapped with a wet paper and refrigerated to keep it in a moist environment throughout the experiment. Previous studies have shown that keeping the model in such an environment was satisfactory (Kaufman & Katz 1993) <sup>(6)</sup>.

Measurements were taken after irrigation with normal saline into the root canals. Cotton tips were used to dry the tooth surface and eliminate the excess irrigating solution.

The file was placed in to the canal while attached to the appropriate electrode of the apex locator and the other electrode (lip clip) was attached to the alginate (figure 1).



Figure 1 show tooth inside alginate with apex locator.

The file size was 20 Flexo file (Dentsply, Maillefer), it was inserted slowly inside the canal till the signal of the apex locator reached the '0' mark (apical foramen), at this point the stopper of the file was moved to the coronal reference point, then the file was removed from the canal and working length was measured with an endodontic ruler and its length registered as the electronic length (EL). On each tooth this procedure was repeated for each one of the six types of apex locators, in this study the apex locators used are

1. Root ZX II (Morita, Japan).
2. Root ZX Mini (Morita, Japan)
3. ipex II (NSK, Japan)
4. Kerr apex ID (Kerr, USA)
5. Root PI apex locator (Osakadental, china)
6. YD2 apex locator (Shanghai S&D Dental International Co., china).

The results obtained (in millimeters) for each electronic apex locator was recorded in independent tables. In each case, we subtracted the corresponding reference measurement (i.e. actual length) from the electronically determined distance, recording the result in tabular form as positive form (measurements exceeding the apical foramen), negative (measurements short of the apical foramen), or correct (measurement coinciding with the actual length) with a  $\pm 0.5$  mm acceptable range.

Percentage was used to statistically analyze the significance of the mean differences between electronic length and actual length.

## Results

Each tooth served as its own control. Statistical results showed Root-ZX II, Root ZX Mini were accurate 96% of the time to  $\pm 0.5$ mm, where as I pex II and Kerr apex ID were accurate 94% of the time to 0.5 mm from the apical foramen, 44%  $\pm 0.5$ mm for the Root PI apex locator and 44%  $\pm 0.5$ mm for the YD2 apex locator Table(1).

**Table (1). Show the Position and percentage of the file tip relative to the apical foramen as determined by the Root-ZX, Kerr, PI and Yd**

Distance from apical foramen (mm)	Root ZXII N=50	%	Root ZX Mini	%	I Pex II N=50	%	Kerr apex ID	%	Root PI N=50	%	YD2 N=50	%
< - 0.5	0	0%	0	0%	1	2%	1	2%	14	28%	13	26%
- 0.5 to 0.5	48	96%	48	96%	47	94%	47	94%	22	44%	22	44%
> 0.5	2	4%	2	4%	2	4%	2	4%	14	28%	15	30%

## Discussion

The main purpose of this study was to evaluate the accuracy of electronic apex locators most widely used in clinical practice that are available in the local markets. An in vitro study was developed in comparing electronic

measurements with a control.

No individual technique is truly satisfactory in determining endodontic working length. Modern electronic apex locators can determine this position with accuracies of greater than 90% but still have some

limitations. (7)

Two operators measured the actual working length (control) with the use of a stereo microscope to be sure that all the samples having a working length of 21mm in order to get a precise measurement and the same operators measured the electronic measurements. All the teeth used were single rooted teeth with mature apices; several studies have demonstrated that EALs can accurately determine the working length in between 75 to 96.5% of the root canals with mature apices (8-11); therefore any tooth with wide or opened apex was neglected because it gave inaccurate readings.

Study carried out by Lucena-Martin et al. (12) showed that the Root ZX gave a precise measure in 85% of the cases. Shabahang et al. (13) produced values to a precision of 96.2% for the Root ZXII which is in general agreement with our study. It was not possible to compare the results of the other five apex locators with other existent studies because of the lack of research on these devices however there was no significant difference in the accuracy between the root ZX II, Root Zx Mini and i pex II and the kerr but all of them significantly differ from the Root PI and YD2 in which there was no significant difference between them.

The accuracy of the Root-ZXII, Root ZX Mini, were accurate 96%, where as i pex II and Kerr apex ID were accurate 94%, 44% for the Root PI and 44% for the YD2. these variations showed a difference in the accuracy of the measurements between the devices.

It is important to mention that these measurements were made in vitro and in ideal situations but clinically there are more problems related in working length measurement like the presence of blood and the use of different irrigate solutions so more studies are needed to evaluate the accuracy of EAL under different situations and also in vitro studies are needed to evaluate the real accuracy of the EAL clinically.

### Conclusions

Within the limitations of this in vitro study the following conclusions could be drawn :

All the apex locators were able to determine the position of the apical foramen but consequently the (Root-ZX II, Root ZX Mini, i Pex II, Kerr apex ID) were more accurate for the determination of the root canal length than (Root PI apex locator and YD2 apex locator).

**Ethical Clearance:** The Research Ethical Committee at scientific research by ethical approval of both environmental and health and higher education and scientific research ministries in Iraq

### Conflict of Interest

The authors declare that they have no conflict of interest.

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