

**Original Research****Accuracy of Electronic Apex Locator and Integrated Apex Locator: Working Length Measurement in Root Canal with Closed Apical Foramen- An In Vivo Study****1. Thumar Sweety**

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**ABSTRACT:**

**Introduction:** One of the most crucial step in an endodontic treatment is Working Length (WL) determination. Nowadays, an important tool for WL determination is a conventional apex locator (EAL). In addition to the EAL, integrated apex locators (IAL) have also developed with the goal of minimising the steps and thereby enhancing the accuracy and reducing the overall time duration. **Aims:** To determine the accuracy of EAL and IAL for Working Length Measurement in Root Canal with Closed Apical Foramen. **Methods and Material:** After obtaining ethical clearance from the institution, a total of 20 patients were included. Procedure was explained to each patient and informed consent was obtained. After local anaesthesia administration, the access cavity preparation was done. The canals were located and the measurements were taken using both apex locators. Immediately after the measurements, the tooth was atraumatically extracted and the actual working length (AL) was then measured by observing under the operating microscope till the file was visible through minor foramen at the magnification of 16x. Silicon stopper was adjusted and the working length was again determined.

**Statistical analysis:** All the measurements were made and the analysis was done by one way ANOVA test. **Results:** The test results showed that there was no statistically significant difference between EAL & IAL in both groups when compared with the AL. **Conclusions:** Both the apex locators are

found to be equally accurate in determining the working length, but mean value of Root ZX mini was found to be nearer to the AL.

**Key-words:** Working Length, Electronic apex locator, Root Canal Working length

## INTRODUCTION

Accuracy of working length determination and proper apical stop aids in limiting instrumentation within the confines of the root canal.<sup>[18]</sup> It is important to estimate the exact root canal length during endodontic therapy in cases of trauma, root resorption, intrusion/ extrusion so as to avoid any injury to the periapical region.<sup>[19],[20]</sup>

Conventional Apex Locators (EALs) are thought to be reliable and effective tools for determining the actual length of the root canal considering the apical foramen as a reference. Also, they have advantages over the radiographic approach, such as a decrease in the quantity of radiographs and exposure, thereby saving time during endodontic treatment.<sup>[21]</sup>

Concerns about the precision of EAL measurements when it comes to the file size, the diameter of the apical third, and the apical foramen of the root canals.<sup>[22]</sup> Inaccuracy in EAL may result into the measurements that are either short of the apex or beyond the apex.(Figure 1) In vital tooth, no consequences are there if the canal is filled shorter than the Actual WL.<sup>[23]</sup> Negative effects could result if necrotic, diseased tissues are left in the apical region.<sup>[24] [25]</sup> Measurements beyond the apex are riskier since they may result in over instrumentation and obturation.<sup>[26]</sup> The maxillary sinus, the mental and mandibular nerves, as well as other nearby anatomical structures, may occasionally also be affected and harmed.<sup>[27]</sup>

Despite having an accuracy between 80 and 90 % in the majority of root canals, there are a number of issues that can limit the function of EAL.<sup>[28] [29]</sup> This are: the size of the file being used, the kind of any electrolytes in the canals, the diameter of the apical foramen, the presence or absence of an apical constriction, the presence of a blood or pus in the canal.<sup>[30]</sup> Anteriors have wider canal as compared to the posteriors.<sup>[31]</sup> And thus determining the working length with the smaller size of the file as compared to the canal width may affect the accuracy of the Electronic Apex Locators (EAL) as well as Integrated Apex Locators (IAL).<sup>[15-17]</sup>

Although some of these constraints have been solved by third-generation EALs. But according to many researchers, larger files may lead to erroneous measurements. According to them, the canal size as large as 60 or more, size 80 or greater or size 90 or greater showed inaccurate results.<sup>[32] [33]</sup> Smaller files had no discernible impact on Root ZX, regardless of canal sizes ranging from 40 to 80. The biggest differences seen when a size 10 file was used in canals that had been prepared to size 80 were 0.19 and 1.11 mm in groups irrigated with sodium hypochlorite (NaOCl) and human blood, respectively.<sup>[34]</sup> In other words, regardless of the size of the measuring file, relatively accurate working lengths can be achieved with the Root ZX in canals containing NaOCl prepared to size 80 without blood and possibly without serum or pus.

Endodontic motors with Integrated Apex Locator (IAL) are created for quick and simple root canal preparation. Along with controlling torque and speed, these devices monitor the apical limit while mechanically preparing the canals.<sup>[35]</sup> . According to one study, these IAL provided an acceptable apical limit in 83-85% of cases.<sup>[36]</sup> But due to the limited literature available, in our study we decided to check the accuracy of IAL with the gold standard i.e., Root ZX Mini (J. Morita Corp., Kyoto, Japan)

Thus, this in vivo study aimed to shed light on the prospect of using an IAL as a replacement or as an adjunct to the EAL so as to determine the accuracy of these Apex Locators in different clinical conditions in the tooth with closed Apical Foramen.

### **SUBJECTS AND METHODS:**

After obtaining the ethical clearance from the institution, a total of 20 patients were included in the study. Procedure was explained to each patient and informed consent was obtained. The teeth included in this study were already planned extractions for orthodontic, periodontal, and prosthodontic reasons. The following exclusion criteria was used: the tooth with any periapical pathology, root resorption, any periodontal condition or any orthodontic condition, patients with cardiac pacemakers as well as those having teeth with calcifications were excluded. The teeth selected were with enough crown structure to get a stable reference point. This study was conducted in a blinded manner, with the first operator determining the working length (WL) on patient using the Root ZX mini, the second operator determining the same using the Eighteenth E Connect S, and the third operator verifying the working length following tooth extraction.

After local anaesthesia administration of 2% lidocaine and 1:100000 adrenaline<sup>[37]</sup> and isolation with rubber dam was carried out, an Endo Access Bur (Dentsply Maillefer, Ballaigues, Switzerland) and Endo-Z Bur (Dentsply Maillefer, Ballaigues, Switzerland) were used for access cavity preparation and refinement of the prepared access, respectively. The canals were located and the canal patency was established using a size 10 K-Files (M-Access, Dentsply Maillefer, Ballaigues, Switzerland). Coronal Pre-Enlargement was done with rotary ProTaper SX files (Dentsply Maillefer, Ballaigues, Switzerland). After flushing the canals with normal saline, measurements were taken using the apex locators appropriate to each group.

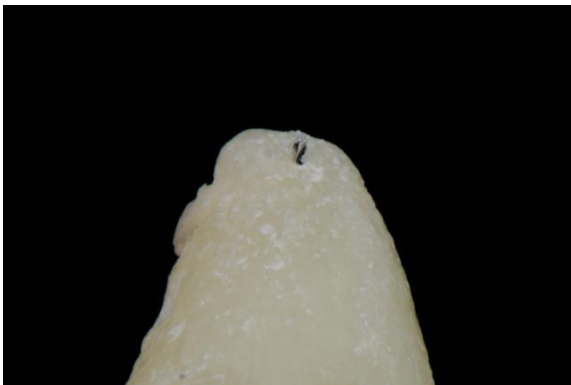
The patients were categorized into the following two groups:

Group 1- Measurements were made with Root ZX Apex Locator (EAL). (n=10)

Group 2 - Measurements were made with Eighteenth E- Connect S (IAL). (n=10)

The manufacturer's instructions for the Root ZX EAL and Eighteenth E Connect S (IAL) were followed when taking measurements. All the measurements taken by the 1<sup>st</sup> operator.

Immediately after the working length measurements were made, the tooth was atraumaticcally extracted and the actual working length (AL) was then measured by observing under the operating microscope-Labomed Prima DNT (Labo America Inc., Fremont, US) till the file was visible through minor foramen at the magnification of 16x. (Figure 2) Silicon stopper was then adjusted and the Working length was again determined by the third operator.



**Figure 1**



**Figure 2**

**Figure 1: File tip extended beyond the minor foramen when examined under the dental operating microscope. Figure 2: File tip visible through the minor foramen when examined under the dental operating microscope.**

All the measurements were made and the analysis was done by using IBM SPSS software version 25.0 (SPSS Inc., Chicago, IL, USA). Statistical analysis was performed by using One-Way ANOVA test.

## RESULTS

The statistical analysis was performed by One-Way ANOVA test. The one-way ANOVA test examines the group means and ascertains if any of the group means vary statistically from the others. This non parametric test is determined on the basis of one independent variable.

When compared to actual WL, the One-Way ANOVA test showed no statistically significant difference between the Root ZX and Eighteenth E-Connect S Integrated AL in determining the minor foramen in either group.

According to table 1, Root ZX mini (EAL) has a higher mean value and Eighteenth E- Connect S (IAL). The mean value of Root ZX mini and Eighteenth E Connect S is  $20.45 \pm 0.380$  and  $20.10 \pm 0.375$  and the actual WL is  $20.55 \pm 0.474$ .

**Table 1: Mean and standard deviation of integrated apex locator, electronic apex locator and actual canal length.**

	MEAN	N*	STD. DEVIATION	STD. ERROR	p VALUE*
Root ZX mini	20.45	20	1.414	0.380	0.084
Eighteenth E-Connect S	20.10	20	1.125	0.375	
Actual Working Length	20.55	20	1.423	0.474	

## DISCUSSION

To keep the preparation inside the restricted radicular area, and a suitable Working length (WL) is crucial step. And this further prevents apical extrusion and ensures effective obturation. EAL have been found to be a useful aid when compared to the conventional radiographic method as it not only reduces the treatment duration but also reduces the radiation dose. Although the EAL outperforms the radiograph in terms of reliability and accuracy, its performance could be compromised by a number of factors, including a lack of patency, the electrical conductivity, or the complexity of the anatomical configuration.<sup>[38]</sup>

For our vivo study, the most advantageous aspect is that this study more accurately captures the conditions that exist in clinical practise.<sup>[39]</sup> Three operators were employed in this study for the determination of working length, which was performed in a blinded way to avoid any bias from the side of the operator.<sup>[40]</sup> Unlike in vitro studies, where in order to replicate the clinical situations, the chances of error are increased. Studies on the accuracy of EALs conducted in vitro have limitations because the human periodontium is not included. Also, the electrolyte may be pushed into the canal space during in vitro model creation, leading to error.<sup>[19]</sup>

However, the widely varied root canal anatomy adversely affects the working length determination and also the canal preparation.<sup>[41]</sup> The anatomical apex is thought to be between 0.5 and 1.0 mm away from the minor apical foramen.<sup>[42]</sup> The Apical Foramen can become asymmetrical under several physiological and pathological circumstances. Before maturation, the Apical Foramen is open; however, over life and after maturation, it decreases and has a funnel shape as a result of the deposition of hard tissue. The anatomical apex is not always where the Apical foramen is located; in particular, the distance between the Apical Foramen and Anatomical Apex is greater in the posterior and permanent teeth than in the anterior and primary teeth.<sup>[43]</sup> However, in teeth with periapical lesions and apical resorption, the minor constriction might be pathologically changed, making it more challenging to determine the exact termination of root ends.<sup>[44]</sup>

In our study, no statistically significant difference was seen. The mean of both the groups were lower than the actual working length (AL). However, the mean working length of Root ZX mini was nearer to the AL as compared to the mean of Eighteeth E- Connect S. Thus, the accuracy of these apex locators may also be influenced by different file sizes and apical foramen diameters.<sup>[45]</sup>

Ebrahim et al determined that equivalent readings were obtained in enlarged canals using both a file with the same diameter as the canal and a consistently smaller file.<sup>[46]</sup> By increasing the diameter of the files used in the measurements to match the foramen diameter, Akisue et al. showed that the accuracy of the EAL decreases as the foramen diameter increases. In order to reduce the possibility of errors, the file used in this investigation was the one that best fit the root apex.<sup>[47]</sup> Manuela Herrera et al. in one study concluded that there was no statistically significant difference between the initial and final working lengths measured by files from #10-#25 in the teeth whose apical width had been increased to 1.02 mm; however, significant differences were seen between #10 and #30, #35, or #40 and the degree of significance significantly increased for files #45 or higher. These findings imply that the accuracy of the Root ZX apex locator changes with apical constriction diameter.<sup>[48]</sup>

Thus, though to establish root canal patency and estimate the initial working length, small-diameter hand files are methodically employed. But in the case of wider canals such as anteriors, the accuracy of an electronic apex locator may be affected by file size.<sup>[49]</sup> This limits the accuracy and stability of the measurements obtained. Hence, the close proximity of the file and the canal walls are likely to responsible for the stable measurements using Apex Locators.

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