



## COMPARATIVE EVALUATION OF THE ACCURACY OF TWO ELECTRONIC APEX LOCATORS WITH CBCT IN DETERMINING THE WORKING LENGTH IN TEETH WITH SIMULATED APICAL ROOT RESORPTION: AN IN VITRO STUDY

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### Abstract:

**Back Ground:** One of the prerequisites for successful endodontic therapy is the determination of correct working length. There is general agreement that the apical constriction is the most appropriate landmark for termination of endodontic therapy. However, this landmark is not always present, especially in cases of root resorption or in teeth with open apices. Thus working length determination becomes crucial.

**Aim:** To compare the accuracy of working length determination of Propex Pixi (Dentsply Sirona, Swiss), Root ZX mini (J Morita, USA) electronic apex locators and cone beam computed tomography (CBCT) in teeth with simulated apical root resorption.

**Materials and Methods:** Twenty mandibular premolars were selected and a 45° oblique cut was made at the apex. Preoperative CBCT was taken and working length is measured. Access opening was done and the teeth were embedded in an alginate mould. Working length was determined using two generations of apex locators, Propex Pixi (Dentsply Sirona, Swiss) and Root ZX mini (J Morita, USA). The length of the file was measured using vernier's calipers and the data was projected to statistical analysis.

**Results:** Root ZX mini was found to be more accurate in determining the working length in comparison with Propex Pixi. However, no statistically significant difference was seen between Root ZX Mini and CBCT.

**Conclusion:** In this present study Root ZX mini measured the tooth length with the greatest accuracy.

**Key Words:** Electronic Apex Locators, Working Length, Apical Root Resorption & CBCT

### Introduction:

Determination of the working length with accuracy is a crucial factor as a prerequisite to successful endodontic therapy. The apical constriction is considered the ideal apical end point for instrumentation during endodontic therapy in a tooth with complete root formation. It is located 0.5-1 mm short of the major apical foramen. [1] Over the years, multiple methods have been postulated to determine the working length of teeth among which electronic apex locators (EALs) are one of the mainstays. Many studies have evaluated the accuracy of working length determination using electronic apex locators and it has been reported that EALs have great accuracy and also reduce the frequency of over-instrumentation. [2] [3] Today, various generations of EALs are available, with every generation asserting to have superior properties over the previous one. A recent systematic review laid emphasis on the precision of electronic working length measurement which depends on the device used. [4] In this study, Root ZX mini which is a modification of a third generation EAL and Propex Pixi which is a fifth generation EAL were used. The accuracy of these two EALs can be evaluated by comparison with Cone Beam Computed Tomography (CBCT) which has been reported to be the most precise means of endodontic working length determination according to various studies. [5] [6] It is an established fact that the accuracy of all EALs is influenced by the presence of apical constriction. [7] However, there is very little literature available on the impact of apical root resorption on the efficiency of EALs for working length determination in permanent teeth. Hence, this study aims to measure the accuracy of two EALs in determining the working length in teeth with simulated apical root resorption.

### Materials and Methods:

Ethical clearance was obtained from the Institution Scientific Review Board before the commencement of the study. Twenty mandibular premolars of 22mm height were selected and randomly numbered from 1 to 20. Inclusion criteria comprised of single-rooted teeth with a single root canal and completely formed apex, and tooth devoid of any pre-existing restoration, caries, or morphologic defect. Tooth with incompletely formed apex or open apex or those with root resorption or cracks were excluded from the study. The occlusal surface of the teeth was flattened to provide a stable reference point. A 45 degree oblique cut was made at the apex using a

diamond disc (Mani, Shuetz) such that the palatal wall is shorter than the facial wall by 3 mm (Figure 1). Pre-operative CBCT taken, 150 micro meter slice thickness, and working length is measured (Figures 2&3). A conventional access preparation was done using endo access bur size 2 (Dentsply, Swiss). Following this, the canal was enlarged with a No.15 stainless steel K-file using 5 ml of saline to establish canal patency. The teeth were then embedded up to the cemento-enamel junction in freshly mixed alginate (Tropicalgin, Zhermack) prepared according to the manufacturer's instructions and poured into a plastic mould. Simultaneously, the labial clip of the EALs was also inserted into the mould. The teeth were removed from the mould on partial set of the alginate and ECG gel (Nu prep, Weaver) was applied to it as an added medium. The teeth were embedded back into the mould again and stabilized. The K-file was then inserted into the canal and the silicone stop was set to the flat anatomical reference point on the crown. The Propex Pixi (Dentsply Sirona, Swiss), Root ZX mini (J Morita, USA) electronic apex locators were then used sequentially to record the working length by the first observer. This was repeated by a second observer to eliminate observer bias. For both the EALs, the readings were taken in accordance with the manufacturer's instruction and all measurements were recorded using a vernier caliper. For the Root ZX mini, the file was advanced until the "APEX" signal was seen on the LED display and then withdrawn until the display showed the 0.5 mm mark (Figure 4). Measurements were considered to be correct if the readings remained stable for at least 5 seconds. For Propex Pixi, the file is inserted until the 0.5 flash bar is reached and there is a change in beeping (Figure 5). The length of the file is then measured using vernier calipers (Figure 6). Three measurements were made for each sample with each EAL by both the observers and an average was taken as the final reading. The CBCT measurements were taken as the control. Statistical analysis was performed using SPSS version 20.0 software. Oneway ANOVA was used to check the significant difference between all groups and to check difference between two groups posthoc tukey was performed. The level of significance was set at  $p < 0.05$ .

**Results:**

The mean difference and standard deviation between the values obtained from each measurement technique and the p-values are shown in Table 1. A statistically significant difference was detected between CBCT and Propex Pixi ( $P=0.03$ ), and Propex Pixi and Root ZX Mini ( $P=0.02$ ), where Root ZX mini was found to be superior in accuracy in determining the working length in comparison with Propex Pixi. However, no statistically significant difference was seen between Root ZX Mini and CBCT ( $P=1.00$ ).

GROUPS	MEAN $\pm$ S.D	p Values
CBCT	19.0250 $\pm$ 0.15 <sup>A</sup>	1* VS 2 ( 0.03)
PROPEX PIXI	18.7575 $\pm$ 0.35 <sup>B</sup>	2 VS 3* (0.02)
ROOT ZX MINI	19.0075 $\pm$ 0.19 <sup>A</sup>	1 VS 3 (1.00)

Table 1

Between each group same superscript alphabets shows no significant difference ( $p > 0.05$ ). Superscript asterisk (\*) indicates the significant group.

**Discussion:**

Correct working length determination is critical to achieve endodontic success, allowing to clean and shape, and obturate the canal system as close as possible to the apical constriction. This is crucial because under obturation as well as over obturation have been shown to increase endodontic failure rate. [8] With the development of EALs, assessment of WL has become more predictable and has helped in overcoming some of the shortcomings of conventional radiographs. Despite having an accuracy of 80–90% in most root canals, the performance of EALs can be limited by multiple factors; one among them being the presence or absence of apical constriction. [9] Electronic apex locators represent important innovations in endodontic treatment. The functionality of these equipments are based on the fact that the electrical conductivity of the tissues surrounding the root apex is greater than the conductivity inside root canal system being the canal dry or filled by non-conductive fluid. [10] In our study, Root ZX Mini is found to be the better electronic apex locator in comparison with Propex Pixi. Root ZX Mini is a modification of the third generation of electronic apex locators. It is a frequency dependant type of apex locator working on the principle of frequency or comparative impedance. They are based on the fact that different sites in the root canal give differences in impedance from high (8KHz) and low frequencies (400Hz). The difference in impedance is least in the coronal part of the canal and increases as the file goes deeper. Utilizing the ratio technique, Root ZX mini provides a highly accurate indication of the file's location which is not affected by the presence or absence of blood, other discharges, electrolytes, saline, tap water, or hydrogen peroxide. Due to its automatic calibration, it ensures accuracy and eliminates the effect of changes in temperature, moisture, etc. inside the canal, even during treatment. [11] In our study, Cone Beam Computed Tomography (CBCT) was used as the standard because of its consistency and reliability to be used as a tool for working length measurements with high precision. This has been documented in various studies. [5] [6] [12] The CBCT has the advantages of less radiation and the possibility of 3-D evaluation. The oblique 45° cut made at the apex was done to closely mimic apical resorption which does not occur in a single plane. [13] The same file size was used in every case (No. 15 K-file) to have comparable conditions for the *in vitro* measurements. Over the years, several electroconductive media have been used for conducting *in*

*vitro* evaluation of the accuracy of apex locators to simulate the clinical situation including agar [14], gelatine [15], flower sponge soaked with 0.9% saline [16], simple saline solution [17] [18], and alginate [19]. When the effectiveness of these various materials was compared, the performance of alginate was found to be superior for the assessment of EALs. This result may be due to alginate's electroconductive properties, which simulate the periodontal ligament with colloidal consistency. Alginate has also been previously shown to simulate the clinical situation better than other gelatin models as it firmly supports the teeth and remains intact for the duration of the study [20]. Alginate mould is also extensively used as it is economical, easy to handle, and may cover the roots, resulting in an objective and unbiased measurement [21]. Due to the fact that alginate mass tends to dehydrate quickly, all the measurements were performed within 30 min as suggested by Topuz *et al.* to prevent any decline in the accuracy of the readings [22]. In our study, we used ECG gel as an added electroconductive medium which has not been used in any other studies conducted previously. The purpose of using this gel is to mimic periapical lesion fluid as in the case of lesion-induced periapical root resorption. Accuracy of EALs can be determined either by *in vitro* or *in vivo* studies. In the present study, *in vitro* evaluation was preferred as it provides with better standardization and objective evaluation of different variables.

#### **Conclusion:**

The determination of the working length of root canal using Root ZX mini (J Morita, USA) was more precise when compared to Propex Pixi (Dentsply Sirona, Swiss).

**Conflicts of Interest:** None Declared.

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