

## ACCURACY OF THE ELECTRONIC APEX LOCATOR IN RELATION TO PATIENT'S COOPERATIVE BEHAVIOR

Zain Hafiz\*

### ABSTRACT

**Background** Root canal length measurement during pulpectomy procedure is an important step for a successful treatment results. The aim of this study is to clinically evaluate the affect of patient's cooperative behavior on the accuracy of Root ZX (EAL).

**Materials and Methods** Thirty-five primary anterior teeth undergoing pulpectomy procedure in 19 healthy children selected. Root ZX (EAL) used for determining the root canal length electronically. X-ray exposure is done with file in place to confirm the initial working length. Using the digital ruler in the Romexis software the radiographic root canal length measurement is estimated. Afterwards, pulpectomy procedure is completed.

**Results** t-test showed no statistical significant difference  $p = .132$  between the Root ZX (EAL) and digital radiography in determining the root canal length in primary anterior teeth. Considering that the clinically acceptable error tolerance should be  $\pm 1$  mm, Root ZX (EAL) showed an accuracy of (85.7%) in 18 and 12 (++ve) and (+ve) behavior patients, respectively.

**Conclusion** Root ZX (EAL) showed acceptable accuracy and are comparable to digital radiography in measuring root canal length in primary anterior teeth in children with positive and definitely positive behavior.

**Key words:** primry teeth, apex locator, cooperation, pulp therapy

### INTRODUCTION

The main purpose of pulp therapy in primary dentition is to preserve the health of the dentition and the surrounding tissues. Pulpectomy is a non-vital root canal procedure for pulp tissue that is irreversibly infected or necrotic in response to caries

or trauma <sup>1</sup>. Removing the infected pulpal tissues, necrotic material and bacteria from the root canal system is crucial for the success of the root canal therapy <sup>2</sup>. Electronic apex locators (EALs) decrease the number of radiographs needed and help where radiographic methods are difficult <sup>3</sup>. Electronic apex locators are usually used to determine the root

\* Lecturer, Department of Pediatric Dentistry and Orthodontics, King Saud University, College of Dentistry, Riyadh, Saudi Arabia

canal length with reported accuracy of 35-100%<sup>4</sup>. Safe and effective treatment for the patient requires understanding and cooperation between both the dentist and the patient<sup>5</sup>.

Soares et al. (2006) reviewed the pediatric dental and endodontic literature but didn't find any reports of strategies for root canal therapy of children<sup>6</sup>. Ghaemmaghami et al. (2008) studied the accuracy of Root ZX (EAL) and found that it accurately measured the root canal length in primary incisors<sup>7</sup>. Kielbassa et al. (2003) studied the accuracy of the Root ZX (EAL) in non-restorable anterior teeth planned to be extracted under general anesthesia. The root length was determined clinically with the Root ZX before the extraction. After extraction, the real length was measured, and the two measurements were compared. They concluded that Root ZX (EAL) could be strongly recommended for root canal length determination in primary teeth, especially when treating fidgety children<sup>8</sup>. A literature search revealed no clinical studies assessing the accuracy of Root ZX (EAL) in primary teeth in relation to patient behavior.

The purpose of this clinical study is to assess the accuracy of the Root ZX (EAL) in relation to the patient's cooperative behavior.

## MATERIALS AND METHODS

Approval has been obtained from the Institutional Review Board of the College of Dentistry Research Center (CDRC). The patients participated in this study are patients who attend the dental clinics of the College of Dentistry, King Saud University, Riyadh. Both Genders were selected. A consent form was obtained from parents/guardians according to the CDRC criteria before initiating the treatment.

In this study, *in vivo* measurements of root canal length in primary maxillary anterior teeth indicated for pulpectomy. Decisions to do root canal treatment were based on radiographic and clinical findings.

Inclusive criteria included teeth with irreversible pulpitis or necrosis. The roots must exhibit little or no resorption. Teeth with non-restorable crowns, periradicular involvement extending to the permanent tooth bud, teeth with underlying cysts, pathologic resorption of more than one-third of the root and excessive internal resorption or those with root canals not visible were excluded. Also, medically compromised children such as: congenital or rheumatic heart disease, hepatitis, leukemia, and children on long-term corticosteroid therapy, or those who are immunocompromised, were excluded.

## Patient's Behavior

Patients participated in this study were chosen according to Frankl's behavior rating scale number 3 (+) positive in which the patient shows acceptance of treatment; cautious behavior at times; willingness to comply with the dentist, at times with reservation and minimal movements during treatment, but patient follows the dentist's directions cooperatively. As well, patients showing number 4 (++) definitely positive behavior in which the patient shows good rapport with the dentist, interest in the dental procedures, laughter and enjoyment were selected<sup>9</sup>.

## Electronic measurement

After applying topical anesthesia 20% benzocaine (Deepak, FL, USA) and administration of local anesthesia 2% xylocane 1:80.000 epinephrine (Dentsply Ltd, Surrey, England), Rubber dam isolation was done (Coltene, Whaledent Inc, USA). The crowns of the teeth indicated for treatment were prepared, so a clear and marked incisal reference points were achieved. The pulp chamber was accessed using large round carbide bur in a high-speed hand-piece. For electronic root canal measurements, Root ZX (Morita, Kyoto, Japan) was used according to the manufacturer's instructions. The ground lead of the (EAL) was placed on the patient's labial commissure, and an endodontic k-file (Kerr, Germany) was clasped to the opposite

electrode. Appropriate file size has been selected and inserted into the canals and advanced apically until the flashing bar on the device's screen displays indicating the correct working length with hearing a clear audible sound. Rubber stopper moved to the coronal reference point to determine the canal length. X-ray was taken with Planmeca Prox using the paralleling method to confirm the appropriate file length in the root canal (Figure 1). The measurement was performed three times, and the average was recorded.

### Radiographic measurement

For radiographic measurement, appropriate file size has been selected by measuring the estimated canal length using Romexis software digital ruler. The file was then placed in the tooth based on the estimated length and x-ray was taken with Planmeca Prox using the paralleling method. Root canal length was measured by Ingle's technique (file 1 mm shorter than radiographic apex) (Ingle, 1957) (Figure 2). For the radiographs, the patient was seated with the head supported, and the occlusal

plane parallel to the ground with the patient wearing a protective lead apron with thyroid collar.

The X-ray machine Planmeca Prox automatically was adjusted to 63kV and exposure time was 125 seconds.

The coronal and root pulpal tissues were removed using K-files and root canals were cleaned and flushed with sodium hypochlorite (1%) and normal saline. Moreover, canals were dried with paper points and filled with a resorbable, bacteriocidal material (a combination paste of iodoform and calcium hydroxide) (Vitapex) (Morita, Kyoto, Japan). Teeth were restored with final restoration and a final periapical radiograph was taken.

### Statistical Analysis

The data was analyzed using SPSS Pc+ software. To describe the study and outcome variable, descriptive statistics (mean, SD., and proportion) were used (Table 1 and Figure 3). Intra-operator reliability of root canal measurements was determined earlier in a pilot study by using intraclass



Fig. (1) Electronic measurement for determining root canal length

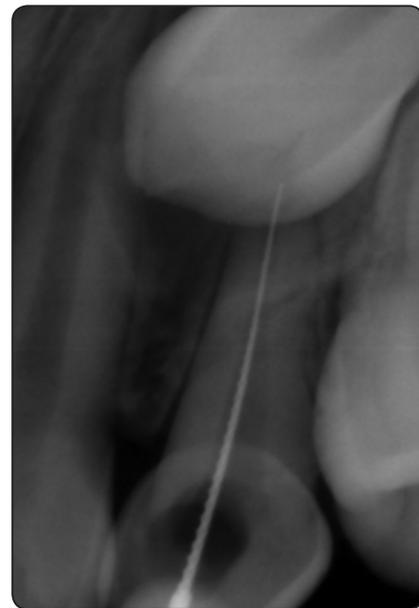


Fig. (2) Radiographic measurement for determining the root canal length

correlation coefficient (ICC). Perason chi-square test was used to observe the relationship between the length values of the two methods (Table 2 and Figure 4). A p-value of < .05 was considered as statistically significant.

TABLE (1) Root Canal Lengths in Primary Anterior Teeth Determined by Different Methods

Methods	N	Mean ± SD (mm)	95% Confidence Interval	Range (mm)
Root ZX	35	13.757± 2.23	lower: 12.99 upper: 14.52	9.00-18.00
Length on RG	35	14.59± 2.321	lower: 13.79 upper: 15.34	9.50-11.5

Statistic : t-test, P = 0.132

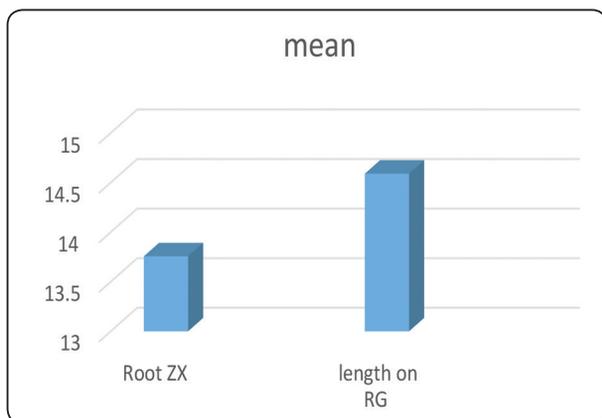


Fig. (3) Root Canal Lengths in Primary Anterior Teeth Determined by Different Methods

Table (2) Patient cooperative behavior in relation to the accuracy Root ZX (EAL)

Measurement difference (mm)	Total frequency (%)	Number of Patient cooperation +ve* (%)	Number of Patient cooperation ++ve**(%)	P value
.5	18 (51.4)	0(0)	18 (100)	-
1.0	12 (34.3)	12 (72.2)	0 (0)	-
1.5	5 (14.3)	5 (27.8)	0 (0)	-

\*n = 17; \*\*n = 18 (χ2 test, α = 0.05).

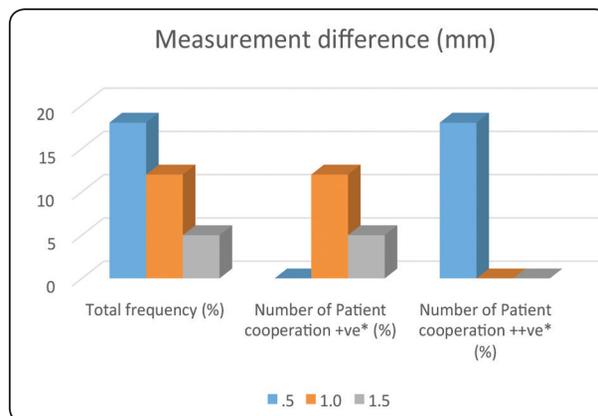


Fig. (4) Patient cooperative behavior in relation to the accuracy Root ZX (EAL)

## RESULTS

Intra-operator reliability test was high (ICC= 0.94). Thirty-five primary anterior teeth in 19 children were used in the study. Total of 70 root canal measurements were accomplished. The means of the root canal lengths in primary anterior teeth were found to be between 14.59 ± 2.321, 13.757 ± 2.23 for the radiographic method and Root ZX (EAL) respectively.

A comparison of the means of the canal lengths indicated no statistically significant difference (P= .132) between the two methods evaluated. Regarding the 35 canals measurements and considering that the clinically acceptable error tolerance should be ±1 mm<sup>10,11</sup>, 18/35 patients with (++ve) behavior (51.4%) showed acceptable root canal length measurements between the two

used methods. As well, 12/35 of the accepted cases were the cases in which the patients showed (+ve) behavior (34.3%) in which the measurements were within the acceptable error tolerance rate ( $\pm 1$  mm). Moreover, 5/35 were the unaccepted cases (14.3 %) in children with (+ve) behavior.

## DISCUSSION

The success of a pulpectomy procedure depends mostly on accurate measurement of the root canal length. A working length that passes beyond the apical foramen may cause overfilling and/or perforation. As well, a working length that is shorter than required may lead to underfilling and/or improper cleaning of the root canal. Failure to remove all the pulpal tissue may cause prolonged pain. Many techniques have been studied to measure the root canal length<sup>7,8,10,11</sup>, but the ideal procedure is not yet confirmed. As a conventional technique, radiographs were the primary tool for determining primary root canal lengths during pulpectomy procedure<sup>12</sup>. Since dental treatment in pediatric patients requires excellent patient cooperation and even under well-controlled conditions with cooperative pediatric patients, dental procedures can be challenging for dentists when the desired outcome is high quality with the least hazardous techniques utilized<sup>13</sup>. In addition to the limitation of using radiographs such as (superimposition and exposure to ionizing radiation), intraoral radiographs are not easy to use in measuring the root canal length due to the poor cooperation and challenging access to the mouth in pediatric dental patients<sup>8</sup>. Up to the author's knowledge, there are no studies available to assess the accuracy of Root ZX (EAL) in relation the pediatric dental patient's behavior. Therefore, this clinical study was conducted to assess the influence of the patient's cooperative behavior on the accuracy of Root ZX (EAL).

In the present study, adopting an error tolerance rate ( $\pm 1$  mm), Root ZX (EAL) showed an accuracy

of (85.7%) in 18 and 12 (++ve) and (+ve) behavior patients, respectively. These results coincide with Kielbassa et al. (2003) who reported that the accuracy of Root ZX (EAL), with a tendency to estimate the root canal length just short ( $\bar{x} = -0.98 \pm 1.75$  mm) of the apex. These results were not affected by the type of the tooth, root canal type, status of periapical area, or clinical condition. They recommended the use of Root ZX (EAL) for clinical implementation of endodontics in primary dentition, particularly when dealing with fidgety children<sup>8</sup>.

Furthermore, Katz et al. (1996) found that radiographic method in determining the root canal length in primary teeth was longer (0.4 mm–0.7 mm) than those obtained with apex locator<sup>14</sup>. These results contradict with the present study since the apex locator's findings ranged from -1mm to +1mm. However, Katz et al. (1996) suggested that Root ZX (EAL) could be used as an auxiliary device to determine the root canal length in the primary teeth<sup>14</sup>. Beltrame et al. (2011) did an *ex vivo* and *in vivo* study to determine root canal length in primary teeth and found that with the a tolerance of  $\pm 1$  mm, the accuracy of Root ZX (EAL) was 92% for root canals with resorption and 94% for the ones without resorption, respectively, *in vivo* and *ex vivo*. They also reported that no significant difference was observed between the resorbed and non-resorbed root canals measured using the Root ZX. They concluded that the Root ZX electronic apex locator was accurate in measuring the working length  $\pm 1$  mm in primary molar teeth regardless of the presence of root resorption<sup>15</sup>. These findings indicate that Root ZX (EAL) accuracy is not affected by different factors which is in agreement with the current study that showed (85.7%) accuracy in patients with (++ve) and (+ve) behavior.

In spite of its limitations, radiographs are inevitable in endodontic therapy. They are needed to select the correct file size, to ensure the absence of morphological abnormality, bony lesions,

and to exclude previous root canal treatment. As well, they are needed post treatment and then periodically to assess the success or failure of the endodontic treatment. However, there is a need to lessen the exposure to ionizing radiation as much as possible<sup>16</sup>. In this study, digital radiography has been used keeping with the ongoing demand for the reduction of the patient being exposed to radiation.

It's recommended to conduct further studies with larger sample size, including the primary molar teeth and assessing the influence of other factors that may influence the accuracy of the Root ZX (EAL) such as different root canal irrigants used during treatment. This study's results show that Root ZX (EAL) seems to be a reliable device for measuring root canal length in primary anterior in (++ve) and (+ve) behavior pediatric dental patients with reducing the hazard of exposure to ionizing radiation.

## CONCLUSION

In this clinical study, Root ZX (EAL) showed acceptable accuracy and are comparable to digital radiography in measuring root canal length in primary anterior teeth in children with positive and definitely positive behavior.

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