

## **A clinical comparison of the accuracy of an electronic apex locator (EAL) and radiography in determination of root canal length in primary molars**

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### **Abstract**

**Objective:** Radiography is yet the most common method for measurement of working length, although it has such limitations as technical disadvantages in children, exposure to x-ray, and difficulty in interpretation of images in primary teeth root canal due to superimposition of permanent teeth bud on the tooth root and so on. The electronic apex locator is a device for measuring tooth canal length. The aim of this in vivo study was to compare the accuracy of an electronic apex locator with conventional radiography as the gold standard in determination of root canal length in necrotic primary molars.

**Materials and methods:** Twenty mandibular primary molars (10 primary first molars and 10 primary second molars) were selected in children between 5 and 7 years of age. Teeth with calcification in pulp chamber and canals, previous root canal therapy and perforation of the floor of pulp chamber due to caries were excluded. Access cavity was created and canal length was determined by NSK EAL and compared with radiography. Pulpectomy was

completed and data was analyzed by paired samples T test using SPSS-16.0 (SPSS Inc, Chicago, IL, USA).

**Results:** in 56 canals (93.3%) the measured length by EAL was equal to radiographic method. In 3 canals (5%) measured length by EAL was 1 millimeter shorter than radiographic length and in 1 canal (1.7%) it was 1 millimeter longer. Paired samples T test failed to show a significant difference between two methods ( $p = 0.85$ ).

**Conclusion:** NSK EAL is accurate for measurement of canal length in primary molars.

**Key words:** electronic apex locator, radiography, working length, pulpectomy, primary molar

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## Introduction

The primary purpose of endodontic therapy in children is conservation of primary teeth and creation of an infection-free oral cavity [1]. It is important to preserve primary teeth until the time of physiologic exfoliation, because early exfoliation of primary teeth may lead to malocclusion, or reduced tooth function. In order to achieve to this goal, early restoration of caries and endodontic therapy is required [2-4]. In endodontic therapy of primary or permanent teeth, determination of working length is critical. Working length should be clearly identified in order not to damage periapical tissues and permanent tooth bud. Knowing the exact location of root apex can prevent over- or under-instrumentation, make an infection-free environment, and prevent invasion to periodontal tissues [5-7].

The complex anatomy of root canal system in primary molars makes it difficult to precisely identify the location of root apex by radiography [8].

Radiography suffers from some technical disadvantages including: inappropriate placement of film in patient's oral cavity, child noncooperation, incorrect angle of x-ray beam, which may cause inappropriate images and make it necessary to re-expose the child for repetition of the radiography [9,10].

Taking radiographs from patients who move frequently or suffer from severe gagging reflex during film placement in the oral cavity is impossible [11].

Recently, use of EALs has made it easy to determine the location of primary teeth root apex [12]. EAL has an important advantage: this method determines the location of apical constriction instead of radiographic apex [13]. So the root length is determined to the real end of apical foramen [14].

EALs are especially useful when apical foramen is not observed in the mesiodistal surface [15]. EALs also make it possible to early diagnose the artificial perforations during the treatment of pulp [16,17]. There are few studies on the measurement of working length by EALs in primary teeth [12]. This study was designed to clinically compare the accuracy of EALs (NSK: Neue Slowenische Kunst, Japan) with radiography for determination of root canal length in primary molars.

## Materials and Methods

This was an in vivo study on 60 root canals from 20 children referred to department of pediatric dentistry of Ahvaz Jondishapour University of medical sciences in 2009 to 2010 who were selected by simple sampling. Twenty seven children in the age range of 5-7 years who were candidates for mandibular primary molar pulpectomy for treatment of abscesses entered the study. Seven children were excluded from the study because of noncooperation during therapy. Teeth with perforation of the floor of pulp chamber due to caries, non-restorability of the crown, pathologic or physiologic resorption of root, intra-canal calcifications did not enter the study.

An informed written consent was obtained from the parents. Using parallel method, a periapical radiograph was taken from the tooth with ultra-speed film (size: 0) before working. Then after assurance from complete anesthesia by Lidocaine and adrenaline with inferior alveolar nerve block and isolation by a rubber dam, all caries were removed by a round bur in a low-speed handpiece; then access cavity was completed by a fissure bur in a high-speed handpiece. The area was washed by normal saline (0.9%). Primary filing was done to reduce remained inflammation and remove necrotic debris. After irrigating, canals were dried by a paper cone. One head of the electrode of EAL (lip clip) was attached to mouth corner and the other one (file holder) was attached to a k-file #15 (Mani, Japan). File was gently introduced to the canal until the EAL monitor showed that it has reached to apical constriction. At this time a rubber stop was set on the coronal reference point and file was removed. This process was done for all 3 canals of each tooth. Then the distance between rubber stop and file apex

was measured by a millimeter ruler (Sunward, Taiwan, China) and measures were recorded as the measured working length by EAL in mm.

For determination of canal length by radiographic method, at first a k-file #15 (Mani, Japan) was placed in the tooth canal using the initial radiograph. Practically, measurement was done 0.5 mm short of the root apex. 2 mm was subtracted from this measure: 1 mm for magnification and distortion and 1 mm for the difference between the location of apical constriction and radiographic apex. Rubber stop was set on the coronal reference point and radiograph was taken by using an X-ray positioning device from canals and the files inside them by parallel method. If the file was in the range of 1-2 mm from radiographic apex, it was approximately corrected. So a second radiograph was not required. Measures were recorded as the radiographic working length. Filing was completed and area was irrigated by normal saline (0.9%). Then a piece of sterile cotton containing 1:5 dilution Buckley's Formocresol solution was placed on the canal orifices. Temporary Zinc Oxide Eugenol dressing with proper consistency was provided and placed in the pulp chamber. One week later the dressing was removed, some filing was done and debridement was completed. Canals were completely dried by paper cone. Then zinc oxide–eugenol (ZOE) paste with creamy consistency was inserted in the canals by spiral paste filler (Lentulo, Denstply De Trey), so canals were filled by ZOE from the orifice to the apex. Then zonalin was put on the canal orifices in the floor of pulp chamber. The excess zonalin was removed from the walls and the tooth was restored by amalgam or stainless steel crown.

The canal length measured by two methods was compared by paired samples T test.

## Results

In the current study, mean canal length was 14.42 and 14.43 mm in electronic and radiographic methods, respectively and the difference was not statistically significant ( $p = 0.85$ ). (Table 1) Mean canal length in primary first molar teeth was 13.83 and 13.82 mm in electronic and radiographic methods, respectively and the difference was not statistically significant ( $p = 0.81$ ). Mean canal length in primary second molar teeth was 15.00 and 15.03 mm in electronic and radiographic methods, respectively and the difference was not statistically significant ( $p = 0.57$ ). (Table 2)

The correlation coefficient between two methods regardless of tooth type was 0.988; this measure for first and second primary molars was 0.984 and 0.99, respectively.

**Table 1. The mean & standard deviation (SD) of canal length (mm) measured by two techniques**

Techniques	Mean	SD
Apex locator	14.42	2.24
Radiographic method	14.43	2.19

**Table 2. The mean & standard deviation of canal length (mm) considering tooth type, and measuring techniques**

Techniques	primary first molar		primary second molar	
	Mean	SD	Mean	SD
Apex locator	13.83	2.13	15	2.22
Radiographic method	13.82	2.05	15.03	2.18

## Discussion

Precise determination of the root canal length is essential for complete cleansing during endodontic treatments and avoidance of files to come out of the canals and safety of treatment regarding damage to permanent tooth bud [18]. EALs are used to precisely identify the location of apical constriction. There are various methods to assess the accuracy of these devices. We compared the accuracy of this device with radiography in the way that canal length was determined by conventional radiography using the initial radiograph. Although there are different methods for measuring root canal length, such as tactile method, using paper points, and electronic method, radiography is yet the gold standard method for this purpose [19]. Radiography with parallel method is considered as gold standard because it is common, and has a high accuracy for determination of canal length [20].

We used primary mandibular molars in order to match the treatment condition. We selected 5-7 year-old children in whom root resorption is lower and they have a better cooperation. Canal length was determined by apex locator to the point that it showed that file is reached to the apical constriction.

The results of the comparison between radiography and NSK EAL for determination of root canal length in primary molars showed that there is not a statistically significant difference between two methods.

McDonald and Hovland examined Endocator (2<sup>nd</sup> generation) in 76 canals from 47 teeth in an in vivo study. In this study the accuracy of the device was 93.3%. According to this study Endocator was an appropriate substitute for radiography and the accuracy of the device was similar to our device, i.e. NSK EAL [21].

Shabahang et al. in an in vivo study to assess the accuracy of root ZX apex locator for determination of the canal length in 26 permanent teeth, found an accuracy of 96.2% in the range of  $\pm 0.5$  mm from apical foramen [22]. In the same year, Pagavino et al. and Donlap et al. found the accuracy of root ZX device in permanent molars to be 92.75% and 92.3%, respectively ( $p > 0.05$ ) which was consistent with the results of our study. The reason for the observed difference in accuracy of electronic method is probably the difference between two apex locators and selecting permanent teeth and a smaller sample size in these two studies.

Subramaniam et al. in an in vitro study compared the accuracy of EAL with conventional radiography in determination of canal length of primary teeth. In this study canal length was  $15.94 \pm 1.42$  mm and  $16.06 \pm 1.73$  mm in EAL and radiography, respectively and the difference was not statistically significant which was in agreement with the results of the current study [23].

Kim Eiseong in an in vivo study, found the accuracy of Root Zx EAL to be 84% and combined accuracy of this device and radiography was 96% (24 canals from 25 cases) and the difference was not statistically significant ( $p > 0.05$ ) [15]. The results were consistent with our results, although they recommended combined use of Root ZX and radiography for determination of root canal length.

Krajczar used radiographic and electronic methods to identify palatal and mesiobuccal canal lengths of extracted maxillary molars and didn't find a statistically significant difference between two methods in palatal canal, although in mesiobuccal canal the difference was significant ( $p = 0.048$ ) [24].

This difference may be caused due to smaller sample size (40 canals in Krajczar study), different apex locator devices, different accuracies in primary or permanent teeth, the difference between in vivo and in vitro conditions, and the difference in statistical analysis.

Neena et al. in a clinical study on primary teeth, considering conventional radiography as the standard method, found that there is no significant difference between methods and electronic method is similar to conventional radiography for determination of canal length [17].

## Conclusion

Considering this fact that there was no significant difference between radiographic and electronic methods in determination of the canal length of primary molars, it is concluded that NSK EAL is a useful device for measuring canal length. One of the disadvantages of this device is unfamiliarity of dentists with the device and its high price. Due to lack of sufficient in vivo researches in this issue, more in vivo studies especially on teeth with root resorption is required.

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