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ORIGINAL ARTICLE

Comparison of the Accuracy of Apex Locators with Conventional Techniques in determining the Root Canal Length in Primary Teeth

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ABSTRACT

Aim: To compare the accuracy of apex locators with conventional techniques in determining the root canal length in primary teeth.

Materials and methods: This *in vitro* study was conducted on twenty extracted primary incisors. After endodontic access preparation, root canals were irrigated with physiological saline solution. The access cavities were dried with cotton pellets and, the roots were dried with paper points before performing the electronic measurement. One operator determined the actual working length (AWL) of the canal and another operator measured working length using conventional F-speed radiographs, digital radiography (Dr Suni Plus digital radiography system, model no 900-0540) and electronic apex locator-Raypex 5 (VDW GmbH Postfach) 5th generation apex locator. The mean value of differences was obtained and statistical analysis was performed using analysis of variance (ANOVA) and the paired t-test.

Results: There was no statistically significant difference between tooth lengths estimate on conventional, digital and apex locators. 0.5 to 1 mm of clinically acceptable discrepancy was found between three techniques.

Conclusion: Although there was no significant statistical difference, electronic apex locator (EAL) has more advantage over other techniques, it is considered accurate in determining the working length in primary teeth.

Keywords: Apex locators, Primary teeth, Radiography, Working length.

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INTRODUCTION

Patient cooperation is very important in performing primary teeth pulpectomies; however, it in turn depends on the procedure and its duration.[1] Determining working length is a necessary step to perform the procedure.[2] The root canal anatomy of primary teeth is difficult to predict because of physiologic root resorption and in the presence of pulp and periodontal inflammation it may further complicate the anatomy.[3]

The principal objective of pulpectomies in pediatric dentistry is to maintain the integrity and function of the primary teeth until physiologic exfoliation.[4] In pulpectomies, the accurate length of the root canal should be determined in order to minimize the periodical injury and risk of damage to the underlying successor.[5] Therefore, one of the major concerns in the root canal treatment of primary teeth is to determine the accurate working length. Most commonly used techniques for determination of working length include tactile sensation, conventional or digital radiography. But, each of these methods has their own limitations.[6] The tactile sensation requires, the clinician be well trained and have good experience. Disadvantages with radiographic methods include distortion of images over position of roots of adjacent structures, two-dimensional view of a three-dimensional image, difficulty in identification of apical foramen due to resorption.[7-9] One more important limitation with conventional radiography is it radiation exposure, need of child cooperation and bulkier/expensive devices.[10]

These limitations led to the shift of choice toward electronic apex locators (EALs). Electronic apex locators were developed by Suzuki (1942) and Sundae (1962).[10,11] They offer the potential to reduce patient exposure to ionizing radiation and lessen procedure time both of which contribute to patient cooperation. However, accuracy of determination of working length with apex locator in primary dentition is believed to be limited because of complicated root anatomy and various stages of physiologic resorption.

Therefore, the aim of this study was to evaluate the accuracy of conventional radiograph, digital radiographs and electronic apex locators in determining root canal length in primary anterior teeth.

MATERIALS AND METHODS

A total of 20 primary single-rooted teeth extracted for periodontal reasons were obtained (Fig. 1). The teeth were kept in 37% aqueous formaldehyde solution with 10% methanol at room temperature until use. Initial pre-operative radiograph of each tooth was taken. Access cavities were prepared using ISO no. 001 round bur in a high speed hand price. Any remnants of pulp tissue were removed using no. 15 barbed broach. Irrigation and debridement of root canal was performed using 3% hydrogen peroxide and 5.25% NaOCl and finally with normal saline. Canals are dried with absorbent paper points. As it is a double blind study where one examiner measured the actual working length (AWL) of the tooth using a no. 20 k file (Fig. 2). Each tooth was measured twice with a metal scale (Fig. 3) and the average was recorded as actual working length of root canal.

The root portion of the teeth were embedded in alginate (Fig. 4) with 0.9% NaCl which acts as a conducting gel simulating the periodontium.[12,13] The readings with RVG, conventional radiograph and electronic apex locator were recorded by another trained examiner.

Conventional Radiography (CR)

Using preoperative radiograph, initial length was taken with a node speed intraoral periapical radiograph using paralleling technique. Determination of working length was done using Ingle's radiographic technique. After developing the film in an automatic X-ray processor it was observed under the view box by magnifying lens and the newly calculated root canal length was recorded.

Radiovisiography (RVG)

It was performed by replacing the film with digital sensor (Dr Suni Plus digital radiography system, model no. 900-0540). Tooth was placed parallel to the tube at a distance of 15 cm. Tooth length was measured directly on the screen of a high resolution monitor with 100% zoom magnification.

Electronic Apex Locator

Raypex 5 (VDW GmbH Postfach) 5th generation apex locator was used in this study. The labial clip was inserted in alginate prior to its setting. Root canal was moistened

Fig. 1: Teeth collected for the study

Fig. 2: Actual working length measurement

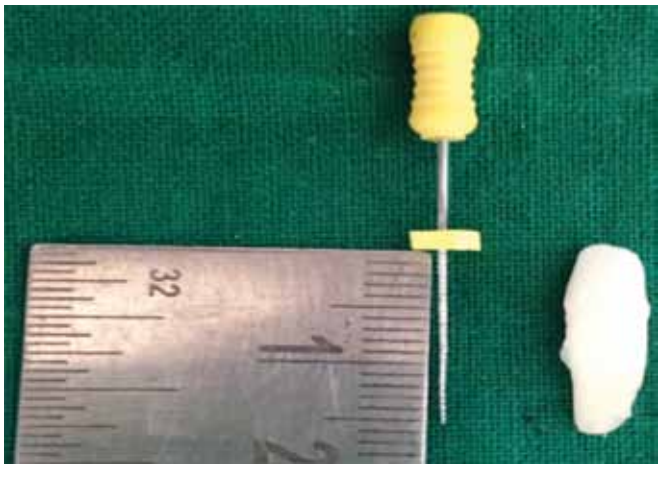
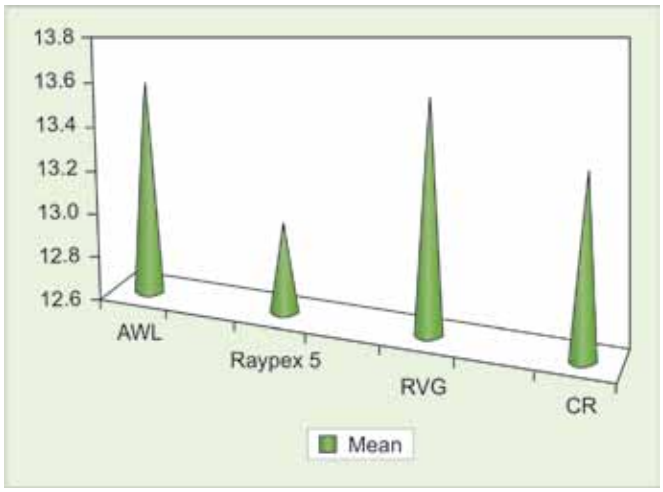


Fig. 3: Actual working length measured using metal scale

Fig. 4: Teeth embedded in alginate

Fig. 5: K-file is clamped to the file clip and is inserted into the root canal



Graph 1: Mean values of working length in graph

with 1% NaOCl. K-file is clamped to the file clip and is inserted into the root canal (Fig. 5). The position of the file can be read on the display. The file movement along the apical region is accompanied by audio signals which increase in frequency the deeper the file advances. As soon as its tip reaches the apical foramen, constant beep will sound and red segment appears on the display. If the readings are stable, the silicone stop was placed at the coronal reference and the electronic root canal length was measured using an endodontic ruler.

The measurements obtained with conventional radiography and EAL was compared to the actual working length.

STATISTICAL ANALYSIS

Data were summarized and the mean reading was calculated for each technique. The paired t-test was used to test the significance of difference of means between each technique and actual canal length.

RESULTS

Mean reading that was obtained with RVG is 13.68. IOPAR gave a mean reading of 13.45 and Raypex 5 resulted in a mean of 13.03. These readings are presented in Table 1 and Graph 1.

The difference of the mean values of each technique from the mean value of AWL (13.58) are not statistically significant ($p > 0.5$) indicating the similarity of mean values of all the techniques to the actual canal length.

Table 1: Mean values of working length determined by four techniques

	N	*Mean*	*Std. deviation*	*f-value*	*p-value*
AWL	20	13.58	1.641	0.628	0.599
Raypex 5	20	13.03	1.923		
RVG	20	13.68	1.407		
CR	20	13.45	1.432		
Total	80	13.43	1.602		

DISCUSSION

Various technical aspects like quality of equipment in the clinic and time taken in obtaining a radiograph and good chairside assistance all play a major role in faster completion of the treatment.

Digital radiography has benefits in pediatric endodontics. It can be able to enhance the contrast and brightness of the image and magnify the apical zone. It can be stored and can be transmitted. Other advantage is patient education, elimination of chemical usage and decreased exposure time. But, the major disadvantage with digital radiography is difficult to place the rigid sensor in a child's mouth and it may cause gag and patient may become uncooperative. Mariane ES et al[14] compared digital and conventional radiography and concluded that both provided similar tooth measurements and were equivalent to actual working length, which validates both techniques for endodontic image acquisition in primary teeth.

In recent years, EAL is developed for determining root canal length with minimum patient discomfort. It is also helpful to overcome the shortcomings of radiographic examination in teeth with resorption.[15] Moreover, the new generation of frequency dependant apex locators is based on electrical principles that can direct narrowest diameter of canal. It can detect the root canal even in the presence of moisture and other conductive fluids. It is also useful in children who gag during radiography.

Raypex 5 is a 5th generation apex locator which shows five basic advantages, such as reliability accurateness, user friendliness, patient friendliness and safety.[16]

The results of the present study confirm that no significant difference found between the primary root canal working lengths obtained with RVG, conventional

radiography and EAL (Raypex 5). Most root canal working length measurements were overestimated or underestimated by less than 1 mm for all these techniques. This minor difference can be considered as clinically acceptable.

The results of the present study agree with other clinical studies. Katz et al[17] evaluated the root canal length of primary teeth obtained with Root ZX and with conventional radiography *in vitro*. They did not find statistically significant results comparing both methods with actual length and recommended the use of these devices in primary teeth as an efficient, fast and comfortable method that should be preferred over radiography. Subramaniam et al[18] conducted an *in vitro* study on 20 extracted single rooted primary teeth comparing the digital tactile sensation technique, apex locator, conventional and digital radiography with the actual length measured under stereomicroscopy. Santos-Pinto et al[19] in an *in vivo* study compared the accuracy of the determination of the canal length using digital radiography with actual length. They did not find statistically significant difference after comparing all the techniques.

Sivadas et al[20] conducted an *ex vivo* study to determine the accuracy of apex locator for root canal length determination of deciduous molars compared to conventional radiograph and found that apex locators can thus be used in resorbed root canals of deciduous molars, with no radiation hazards and processing difficulties. Mello et al[13] conducted an *ex vivo* performance of five methods for root canal length determination in primary anterior teeth and concluded that the EAL method performed best for root canal length determination in primary teeth. Krishnan[12] performed an *in vitro* study comparing electronic and radiographic determination of root canal length in primary teeth and concluded that EAL proved to be more accurate in determining root canal length than the radiographic method.

CONCLUSION

The use of EAL is more equally reliable compared to other methods and it can prove as a best method in pediatric endodontics as it is safe, painless, less fear evoking, no risk of radiation exposure and timesaving.

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