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Original Article

Effectiveness of Electronic Apex Locator during the Root Canal Length in Primary Teeth: An In Vitro Study

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Abstract

Objective: To evaluate the use of electronic apex locator to measure the root canal length in primary teeth, comparing this measure with the measurements obtained by conventional radiography and by the direct measurement of the root canal length. **Material and Methods:** The sample consisted of nine multi-rooted primary teeth, totaling 32 root canals. Endodontic access was performed with a spherical diamond tip, then the pulp was extirpated and the canal irrigated with 0.9% saline. An endodontic file was used to measure the root canal length by electronic apex locator, using the Novapex® according to the manufacturer's instructions, and by direct method. An endodontic ruler was used to determine file's length. Conventional radiographic was also performed. Statistical analysis was performed by analysis of variance (ANOVA). The level of significance was 95%. **Results:** The average of the root canal length was 9.98 ± 2.16 to the direct method; 11.52 ± 1.87 to conventional radiography; and 10.91 ± 1.92 to the electronic apex locator. The results of this study showed a high correlation between the values given by the different methods, regardless of the presence or absence of physiological root resorption. There were not statistically significant differences amongst the methods studied ($p > 0.05$). **Conclusion:** Electronic apex locator was an accurate method measure the root canal length in primary teeth, and its use is indicated in endodontic treatment of these teeth.

Keywords: Primary teeth; Electronic apex locator; Root canal length.

Introduction

Endodontic treatment in primary dentition aims to preserve tooth health in the oral cavity until the time of its exfoliation. One of the critical aspects in this therapy is the determination of the root canal length in order to allow suitable microbial disinfection promoting cleaning, filing and adequate airtight sealing. Instrumentation or overfilling can cause damage to the germ of the permanent successor and in contrast, poor filling may be a risk factor for the persistence of apical infection [1,2].

Although radiography is still the method of choice for determining the working root canal length, electronic apex locator (EAL) is presented as a promising method in determining the root canal length in primary teeth. This method has been studied since the beginning of last century in order to add precision to endodontic procedures, technical speed and reliability in measurement aiming to determine the exact location of the apical foramen and thus accurately establish the working length during endodontic treatment.

The use of EAL in determining the working length has grown considerably in recent years and is used not only in permanent teeth [3,4] but also in primary teeth [2,5-7]. EAL has some advantages over other methods such as radiographic, and new generations of these devices can detect the narrowest diameter of the channel even in the presence of moisture and fluids inside the root canal [8,9].

However, the use of EAL involves financial investment and training required to use it according to manufacturer's instructions. In addition, some authors [10-12] state that the accuracy of EAL can be affected by different types of electrolytes present in root canals and that the foramen size and pulp vitality can also influence the accuracy of the device.

Thus, the aim of this study was to evaluate *in vitro* the use of electronic apex locator to determine the root canal length in primary teeth, comparing the measurement obtained with EAL with measures obtained by conventional radiography and the actual root canal length. This study started with the null hypothesis that there was no statistical difference between electronic and radiographic methods used to obtain root canal length in primary teeth.

Material and Methods

Sample Selection

The sample consisted of nine primary multi-rooted teeth (totaling 32 root canals) extracted at the Clinic of Pediatric Dentistry, Faculty of Pharmacy, Dentistry and Nursing (FFOE), Federal University of Ceará (UFC). Teeth were extracted due to the impossibility of performing endodontic treatment as a result of extensive coronary destruction that impaired the absolute isolation of the operative field or the subsequent restoration or when one or more roots presented root resorption more than two thirds.

This study was approved by the Ethics Committee of the UFC (protocol number 338/11).

Prior Preparation of Teeth

After extraction, both for maintenance as previous preparation for the study, teeth were immersed in 5.25% sodium hypochlorite solution for 15 minutes to remove organic residues from the surfaces of roots, being aided by curettes. Then, teeth were immersed in 0.1% thymol solution for storage under cooling to approximately 4 °C.

Endodontic access was initially performed with a spherical diamond tip at high speed refrigerated with air / water, followed by compensatory wear and finishing of the surrounding walls to allow the entry of the endodontic file without possible interferences. Pulp was excised and the root canal was irrigated with 0.9% physiological saline. Excess saline was removed with cotton wool and absorbent paper.

Measurement using the Apex Locator

To obtain the working canal root length by electronic method, teeth were placed in plastic cylinders with a fresh mixture of colorless and tasteless gelatin for fixing purposes [8]. A K # 10 file (Dentsply-Malleifer, Ballaigues, Switzerland) was attached to the machine's handle and during its insertion into the canal root, measures were monitored on the device display until the instrument reached 0.5 mm. At this time, controls have been adjusted taking as reference the most coronary outer portion of the tooth. Marking was performed with the aid of a permanent marking pen. Subsequently, the file was removed from the root canal and the canal length was obtained by measuring the file length with the aid of an endodontic ruler.

Measurement by Conventional Radiography

At this stage, conventional radiographs were performed to measure the root canal length. This required the use of ultraspeed films (Eastman Kodak Company- Rochester-NY-USA size 2) and X-ray machine (Heliodent- Siemens-USA) with 60 kVp, 10 mA, and exposure time of 0.5 second. After obtaining the radiographic image, the root canal length was measured with the aid of light box and endodontic ruler.

Measurement by Direct Method

With the tooth in hand, a new K #10 file was used, being introduced into the root canal to observe its output by the apical foramen or by any resorption, moving back half millimeter, having as reference the same external point previously marked with marking pen. Then, the length was measured with the aid of the endodontic ruler. Data were collected and considered as positive control group of this study.

Statistical Analysis

Data were tabulated using Excel for Windows 7.0 and were analyzed using SPSS software version 20.0. Descriptive analysis was performed to obtain the mean and standard deviation of

measurements obtained. Then, analysis of variance (ANOVA) was performed to compare the variance of data and to verify whether there was any association between them. The significance level adopted was 95%.

Results

Total primary teeth used in this study and their average root canal length are shown in Table 1. The average root canal length was 9.98 ± 2.16 using the direct method; 11.52 ± 1.87 using radiography; and 10.91 ± 1.92 using EAL. Through analysis of variance, it was observed that there was no statistically significant difference between root canal length obtained using different methods analyzed ($p > 0.05$) (Table 2).

Table 1. Descriptive statistical analysis of measurements obtained through different methods used to measure the root canal length in primary teeth.

	N	Minimum	Maximum	Mean	Standard Deviation
Measure using apex locator	32	8.00	14.62	10.9133	1.92653
Measure using radiography	32	9.25	13.87	11.5211	1.87843
Direct measure with file	32	6.87	12.66	9.9833	2.16798
N valid (from the list)	32				

Table 2. Analysis of variance of length obtained through different methods to measure the root canal length in primary teeth.

		Sum of squares	DF	Mean square	F	Sig.
Measure using apex locator	Between groups	22.614	5	4.523	1.917	.314
	Within groups	7.078	3	2.359		
	Total	29.692	8			
Measure using radiography	Between groups	24.667	5	4.933	4.156	.135
	Within groups	3.561	3	1.187		
	Total	28.228	8			
Direct measure	Between groups	15.349	5	3.070	3.588	.161
	Within groups	2.567	3	0.856		
	Total	17.916	8			

Discussion

Obtaining the working length during root canal treatment in primary teeth is necessary to ensure thorough cleaning and disinfecting of root canals, as well as to prevent damage to the germ of the permanent successor. Among the methods commonly used for this purpose, conventional radiography and EAL stand out. The use of EAL overcomes several limitations of the radiographic method such as occurrence of anatomical variations in the root canal system, interference from adjacent anatomical structures while acquiring the image and technical errors during radiography, processing or even during film storage [9]. Furthermore, the patient may move during radiography or remove the film from the correct position, requiring the acquisition of a new radiography [7].

To perform an effective dental treatment in children, child management becomes essential. It is necessary to provide comfort, safety and speed during procedures to ensure proper treatment. Thus, the use of EAL would assist in the execution of endodontic treatment in primary teeth.

The determination of the working length through the use of EAL has grown considerably in recent years and is used not only in permanent teeth [3,4], but also in primary teeth [2,5-7].

Previous studies have reported that an error from ± 0.5 mm [10] to ± 1.0 mm [11] is acceptable when electronically determining the root canal length. Additionally, some studies that evaluated the accuracy of this method in primary teeth have shown that measurements obtained by the electronic method are closer to the previously established working length than those radiographically obtained [1,10].

Several studies evaluating the effectiveness of EAL in primary teeth have shown satisfactory results [1,5]. Moreover, the effectiveness of measures electronically obtained using Novapex® was similar to those obtained by other authors using various other types of EALs such as Formatron D10 (Parkell Electronic Division, NY, USA), Root ZX II (J. Morita Mfg Corp., Kyoto, Japan) and Mini Apex Locator (Sybron Endo, California, USA), and even the Apex DSP Locator (Septodont®, Brazil) in primary teeth [5,6,10].

In recent decades, it was believed that the use of EAL would be contraindicated in children, as this would not be necessary in cases of teeth under root resorption processes, natural event during the exfoliation of primary teeth. However, in a recent study [7], the authors concluded that these devices are able to accurately determine the working length of root canals in multi-rooted primary teeth, with or without physiological apical resorption, confirming similar results previously found [1].

In this study, measurements obtained by the different methods were similar, and statistically significant differences were not observed. Then, with the excellent results obtained with this study, the use of this device is indicated in children.

Conclusion

Evaluating the results of this *in vitro* study, it was observed that the Novapex® apex locator was effective in determining the working length in multi-rooted primary teeth with or without root resorption. In addition, the use of the electronic device to locate the root apex provides efficiency, speed and security, making treatment faster and safer.

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